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EDISON ELECTRIC INSTITUTE BULLETIN

SEPTEMBER, 1938

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EDISON ELECTRIC INSTITUTE

STATISTICAL DATA OF THE ELECTRIC LIGHT AND POWER INDUSTRY

Compiled Monthly by the Edison Electric Institute—Covers 100% of the Industry

DURING THE MONTH OF JUNE

	1938	1937	%
	SOURCE OF ENERGY		
Kilowatthours Generated (Net)			
By Fuel Burning Plants	5,293,700,000	6,099,477,000	−13.2
By Water Power	3,434,974,000	3,509,046,000	− 2.1
Total Generation	8,728,674,000	9,608,523,000	− 9.2
Net Purchases			
From Other Sources	298,784,000	267,184,000	+11.8
Net International Imports	92,537,000	108,145,000	−14.4
Total Purchased Power (Net)	391,321,000	375,329,000	+ 4.3
Total Input	**9,119,995,000**	**9,983,852,000**	− 8.7
	DISPOSAL OF ENERGY		
Total Sales	**7,436,930,000**	**8,261,249,000**	(a)
Energy Not Reported as Sold			
Used in Electric Railway Department	30,479,000	45,560,000	(a)
Used in Electric and Other Departments	147,217,000	146,723,000	(a)
Furnished Free or Exchanged in Kind	8,213,000	(Not Shown)	(a)
Total Not Reported as Sold	185,909,000	192,283,000	(a)
Total Energy Accounted For	**7,622,839,000**	**8,453,532,000**	− 9.8
Losses and Energy Unaccounted For	1,497,156,000	1,530,320,000	− 2.2
Total Output (To Check Above "**Input**")	**9,119,995,000**	**9,983,852,000**	− 8.7

CLASSIFICATION OF KILOWATTHOUR SALES

Based on FPC Classification—June 1938		**Based on EEI Classification—June 1937**	
Residential or Domestic	1,480,628,000	Domestic	1,337,963,000
Rural	(Allocated to Other Classes)	Commercial—Small Light and Power	1,403,879,000
Commercial and Industrial	5,185,490,000	Commercial—Large Light and Power	4,875,688,000
Public Street and Highway Lighting	125,301,000	Municipal Street Lighting	151,748,000
Other Public Authorities	193,079,000	Street and Interurban Railways	330,855,000
Sales to Railroads and Railways	413,743,000	Electric Steam Railroads	97,450,000
Interdepartmental	33,705,000	Municipal and Miscellaneous	83,666,000
Other Sales	4,984,000		
Total Sales	7,436,930,000	Sales to Ultimate Customers	8,261,249,000

CLASSIFICATION OF CUSTOMERS

Based on FPC Classification—June 30, 1938		**Based on EEI Classification—June 30, 1937**	
Residential or Domestic	22,825,921	Domestic	22,105,787
Rural	(Allocated to Other Classes)	Commercial—Small Light and Power	3,851,151
Commercial and Industrial	4,556,707	Commercial—Large Light and Power	549,378
Public Street and Highway Lighting	25,995	Municipal Street Lighting	34,047
Other Public Authorities	74,263	Street and Interurban Railways	328
Railroads and Railways	282	Electric Steam Railroads	26
Interdepartmental	305	Municipal and Miscellaneous	35,930
Others	3,506		
Total Customers	27,486,979	Total Ultimate Customers	26,576,647

REVENUE (b)

Based on FPC Classification—June 1938		**Based on EEI Classification—June 1937**	
Revenue from Sales Excluding Sales to Other Public Utilities	$172,319,600	Revenue from Ultimate Customers	$175,796,900
Other Revenue	1,951,400		
Total Revenue	$174,271,000		

ESTIMATED DOMESTIC ELECTRIC SERVICE RATIOS

(For the 12 Months Ended June 30th)

	1938	1937	%
Kilowatthours per Customer	829	766	+ 8.2
Average Annual Bill	$35.73	$34.64	+ 3.2
Revenue per Kwhr	4.31¢	4.52¢	− 4.6

(a) Data for two years not strictly comparable.
(b) Data not comparable because of an unascertainable amount of "Revenue in June 1938 which may or may not have been included in the 1937 data.

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EDISON ELECTRIC INSTITUTE BULLETIN

Volume 6 SEPTEMBER, 1938 No. 9

Supply of Energy for Household Purposes in the United States

By C. W. Kellogg

President, Edison Electric Institute, Chairman, Engineers Public Service Company, New York, N. Y.

A paper presented before the Vienna Sectional Meeting of the World Power Conference, Vienna, Aug. 25-Sept. 2.

In two parts—Part I

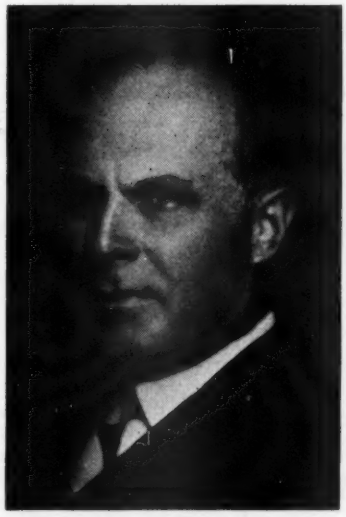
ELECTRIC service in the home began with lighting. It developed shortly after the invention of the incandescent lamp. At first only the homes of the more prosperous living close to the commercial centers of cities were served but in the course of time technical improvements in the art of distributing electric energy made it possible to supply customers at increasingly large distances from power houses. Lighting was practically the sole household use of electricity for nearly twenty years. With the introduction of domestic heat using appliances and motor operated appliances consumption has increased at an accelerating rate. New devices give promise of a continuation of this increase for years to come. Table I and Figure 1 show the growth of the use of household electricity.

It should be observed that these statistics are for household use alone and do not include commercial lighting use.

Percentage of Households Served

The present population of the United States is estimated to be 129,337,000, or about 32,300,000 families. The Federal Census of 1930 showed that the urban population, that is the population living in communities of 2,500 and over, amounted to 56.2 per cent of the total and the rural population was 43.8 per cent. Assuming these proportions still obtain, there are about 17,800,000 urban families and about 14,200,000 families living in rural areas. Approximately 7,000,000 of these rural families live on scattered farms.

As of December 31, 1937, there were 22,939,000 residence and farm customers



MR. KELLOGG

actually receiving electric service, and it is estimated that in addition between 1,300,000 and 1,500,000 families live in buildings which are served with electricity supplied on commercial rate schedules. Thus about 80 per cent of the total population is using electric service. Electric service is available, it is estimated, to an additional 4 per cent of the population which does not make use of it. All of the urban population has electric service available and about 70 per cent of the rural population has electric service available. Practically no communities with 250 inhabitants are without electric service. The only part of the country's population to which electricity is not generally available is that living in those agricultural areas where distances are great and the homes widely scattered. The colored (negro) population in certain sections of the country is also a factor in reducing the percentage of electrification.

Consumption per Household Customer

The consumption of electricity per household, excluding farm homes, at the end of 1937 averaged 793 kilowatthours per annum. The average farm use in areas where irrigation is not a factor was over 1,000 kilowatthours per an-

TABLE I—DOMESTIC USE OF ELECTRICITY
(Source: Edison Electric Institute)

Year	Number of customers (Average of year)	Total kwhr used	Year	Number of customers (Average of year)	Total kwhr used
1882	.....	.....	1912	3,480,000	920,000,000
1887	11,000	1,100,000	1917	6,000,000	1,600,000,000
1892	37,000	5,500,000	1922	10,650,000	3,825,000,000
1897	138,000	27,600,000	1927	17,300,000	7,676,000,000
1902	530,000	133,000,000	1932	19,955,000	11,987,000,000
1907	1,730,000	440,000,000	1937	22,121,000	17,733,000,000

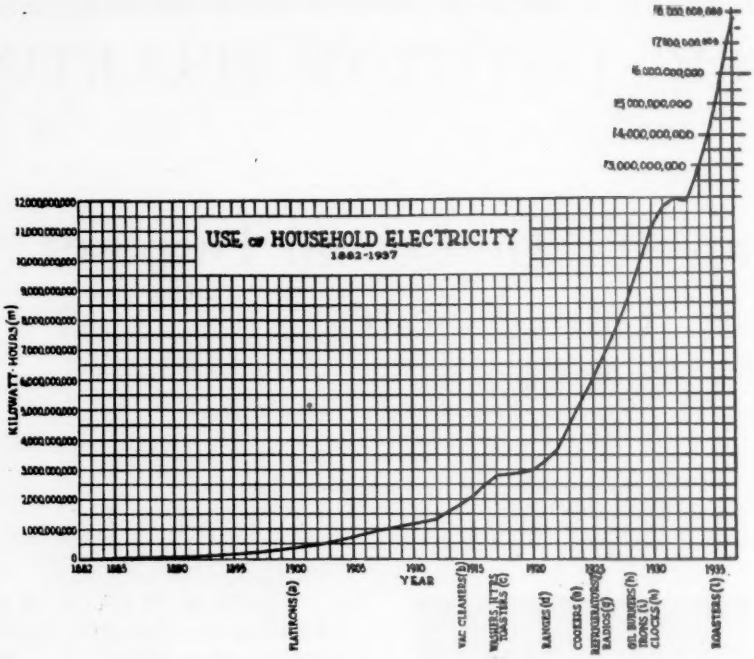


Fig. 1—Use of household electricity, 1882-1937.

num, and the average for both these classes of customers was 802 kilowatt-hours in 1937. In agricultural areas where there is pumping for irrigation the farm uses are substantially greater, and such farms are therefore treated as commercial customers.

Table II shows the increase in the average annual use per residence customer over a period of years. In connection with Tables IV and V and Figure 3, it illustrates the influence of the invention, development and public acceptance through intensive sales efforts of new household appliances.

TABLE II—AVERAGE ANNUAL USE PER HOUSEHOLD. (EXCLUDING FARM HOMES)

Year	No. of kwhr	Year	No. of kwhr	Year	No. of kwhr
1913	264	1922	359	1931	578
1914	268	1923	368	1932	597
1915	260	1924	378	1933	595
1916	265	1925	398	1934	624
1917	268	1926	428	1935	672
1918	272	1927	444	1936	727
1919	293	1928	460	1937	793
1920	339	1929	499		
1921	347	1930	543		

Relative Importance of Household Electricity to Total Electric Business

Sales of electricity for household consumption in 1937 constituted 18 per cent of the total sales of the power supply industry and provided 35½ per cent of the total revenue. Their increase in importance is shown by the fact that twenty-five years ago the sales of electricity for household consumption amounted to 8 per cent of the total sales and provided 26 per cent of the total revenue. Table III and Figure 2 show the growth of the proportion of household consumption to total consumption.

DISTRIBUTION OF ENERGY

Distribution of electrical energy for household purposes is accomplished by supply from many of the medium and low voltage systems of street conductors. The characteristic and by far the most common system is that employing overhead radial feeders energized at primary voltages of from 2300 volts to 13,200 volts, single- or multi-phase, mounted on wooden poles set at the curb line in the public streets. These poles also support transformers and relatively short secondary circuits of 120—240 volts from which supplies are tapped to the consumers' premises. The predominant system is 4000 volts, 3-phase, and single-phase branches therefrom. Although underground systems of distribution are extensively used, they do not, under typical conditions, extend very far into residential districts.

TABLE III—RELATIVE IMPORTANCE OF HOUSEHOLD ELECTRICITY IN THE TOTAL ELECTRIC SALES IN THE UNITED STATES
(Source: Edison Electric Institute)

Year	Household electricity is per cent of total	
	kwhr sold	revenue
1912	7.8	26.3
1917	6.5	22.8
1922	10.5	27.4
1927	12.5	31.5
1932	18.7	36.5
1937	18.0	35.5

In the larger cities, extensive underground low tension networks exist which extend into high class residential areas and also serve large number of multiple dwellings of all classes. Practically all American underground systems for general electrical distribution are installed in drawing in-and-out ducts. The practice of using ducts is relatively expensive and also imposes a more severe temperature limitation upon the capacity of the conductors, compared with the alternative practice of laying conductors in direct contact with the soil.

In spite of these adverse factors, the standards of service and the requirements of consumers in American metropolitan cities are such that the duct system is indispensable for maintaining these service standards. In the event of failure in an underground conductor the affected conductor must be immediately accessible for repair. The wider the field of application of electricity becomes and the greater the consumer's use of the electricity, the greater becomes his dependence upon it, rendering more and more important provisions to minimize the frequency and duration of interruptions to service.

Another factor which has determined the adoption of the duct system for practically all underground circuits in urban areas is the importance of being able to effect repairs to underground circuits, so far as possible, without the necessity of breaking up the street pavement. The relatively high cost of labor and the demand that there be no serious interfer-

ence with street traffic, which in metropolitan cities is ordinarily very dense, render this important. A further factor affecting the choice of ducts is that in the streets below the pavement the ground is generally crowded with other facilities, such as gas, water and steam pipes and ducts for telephone and other signal cables.

In any comparison of American and European distribution practice it is necessary to take into account the lesser density of population in American Cities. Except for a strip along the Atlantic Coast, cities and towns have grown with great rapidity. Chicago, on Lake Michigan, for example, has grown from a frontier trading post to a metropolis of over 3,000,000 people within one hundred years. This rapid growth and the availability of land has produced an open type of development and considerable freedom in the design of medium and low income classes of dwellings.

While there are many multi-unit dwellings, it is quite common, and even typical, to find detached single-family cottages in working class districts of towns. More elaborate dwellings of middle income classes are almost invariably set in plots having fifty to one hundred feet (15 to 30 meters) street frontage.

This characteristic low density of population in residential areas of all classes has brought about the need for relatively large amounts of wire to supply a given load, has diminished opportunities for developing interconnected secondary networks, and, due to the requirements of voltage regulation and the relatively wide spacing of transformers, has limited the full realization of local diversity. Also, on account of wide extremes of temperature and of climatic conditions prevalent in most parts of America, it has been necessary to design for greater margins in mechanical strength and electrical loading than would be the case where more equable climatic conditions prevail. The combined effect of all of these factors has been to render the distribution systems serving residential areas considerably more costly than in other parts of the world and definitely high in cost with relation to any probable revenue that may be expected from the consumers served by them at the existing level of tariffs.

Supply to dwellings is ordinarily accomplished by means of a single flying span of service conductors, attached to the low-voltage mains at the nearest pole and terminating at a convenient point on the dwelling to be supplied. For small installations this "service" may be a 2-wire, 120-volt circuit derived from one of the line wires and the neutral of the 3-wire 120—240 volt secondary main. Recently, however, on account of the increasing use of appliances and higher levels of illumination, 3-wire 120—240 volt services of ample capacity have been supplied extensively.

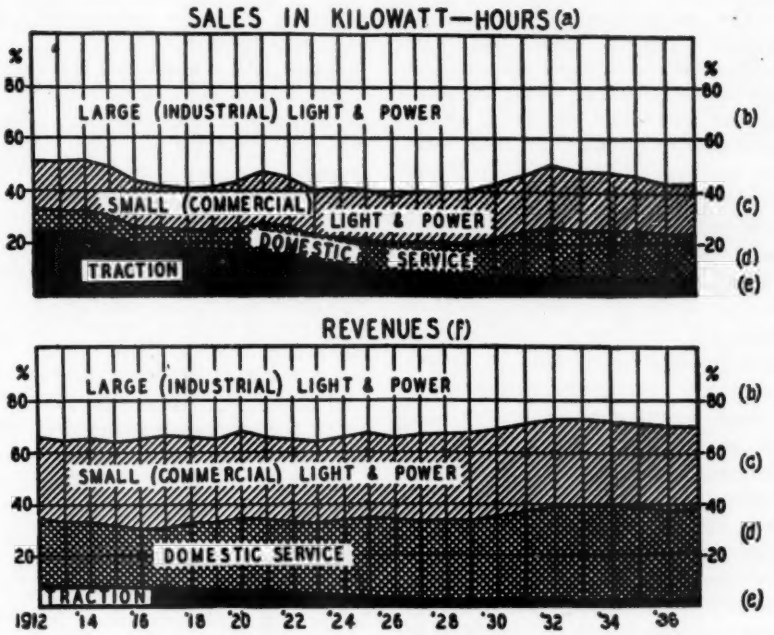


Fig. 2—Proportions, in the Grand Total, of sales of various classes of electric service. (Including, in earlier years, the "Light and Power Departments" of Electric Railways).

Since it is generally convenient both to the supply company and the consumers to locate the meter and control equipment in the cellars or lower stories of dwellings, for purposes of inspection, testing and meter reading, the supply conductors are ordinarily led down the exterior surface of the house wall to a point near the ground, where they pierce the wall and enter the premises. In recent years the practice of installing watthour meters on the outside of the house, before the conductors enter the premises, has been widely followed. This practice permits inspection and testing of the meter from outside and makes it unnecessary to procure admission to the premises or disturb the inhabitants for this purpose.

The interior wiring of consumers' premises in America, with few special exceptions, is the property of the owner of the premises and installed for him by an independent contractor specializing in such work. Practically no wiring of consumers' premises is done by the supply companies; even in those cases mentioned later where supply companies for promotional reasons may finance the installation of certain appliance circuits, the actual work is ordinarily done by independent contractors.

European readers will bear in mind that 115 or 120 volts are used in the United States for lamps and house appliances, or, in the case of 3-wire appliances, such as ranges, 120—240 volts. Current loads on conductors are therefore about double the current found under similar load conditions in countries employing 220 volt lamps and circuits.

The interior wiring of dwellings has not advanced as far as the other branches of electricity distribution, probably for the reason that it has not, until quite recently, received any engineering attention. Very few dwelling houses have wiring systems that are actually designed either by the architects or by engineers. The usual practice has been for the contractor by rule-of-thumb to extend two or three 2-wire circuits from the point of supply to the various points or outlets throughout the house. This practice has a tendency to result in excessively long circuits with little capacity for expansion when new appliances or additional lights are installed.

The introduction of heavy-use appliances, such as ranges and water heaters, therefore created a serious problem in interior wiring which was solved by the installation of special circuits having suitable capacity for these heavy-use appliances. The provision of such circuits therefore became a part of the problem of promoting the use of heavy-use appliances which has been solved in various ways, sometimes by including the cost of the circuit in the price of the appliance, sometimes by subsidizing this cost, but most successfully by devising new types of inexpensive wiring.

Such special measures do not solve the question of the general efficiency of domestic wiring, however. If domestic wiring installations are to keep pace with the probable future use of appliances of all kinds and with desirable increases in the general level of lighting intensity, it is apparent that some systematic engineering design should be applied to them. In general, it appears that the outstanding needs are for the abandonment of the typical long meandering circuit and the substitution of stout feeders to several local centers of distribution, from which many short final circuits may radiate to outlet points.

The regulation due to IR drop on interior lighting circuits is far from ideal, but it is not practically of great importance in domestic installations on account of the low utilization factors of such circuits; moreover, since this wiring is the actual property of the consumer or his landlord, the supply company is limited to advisory services. It is therefore the practice of supply companies to regulate for the pressure delivered at the point of supply in customers' premises; ideally this pressure may be adjusted to the rated voltage of the lamps or appliances in use, allowing 2 per cent for IR drop in interior wiring. Practically a variation of plus or minus 4 per cent from the standard will comply with the requirements for satisfactory service.

No great difficulty is met in maintaining or regulating secondary supply pressure where networks are used. The difficulty may be somewhat greater in the case of radial circuits which, as noted elsewhere, serve most of the domestic load, but except in the case of mixed circuits which include substantial industrial power load, it has proved to be possible to maintain reasonably uniform supply voltage without excessive flicker, at moderate expense for ordinary densities of loading.

A particular problem that is frequently met in growing systems is the reconciliation of a network secondary voltage with that provided by radial feeders. Networks are usually established in the commercial districts of cities, to provide for increasing load densities. For reasons of economy of transformers and conductors, these networks are designed with 3-phase, 4-wire secondaries, where, if the neutral voltages are used for lighting supply and the delta voltages for power, combinations such as 115/199 and 120/208 are obtained. The areas outside of the network area will continue to be supplied by circuits giving single-phase lighting voltages of 115/230, 120/240, etc., and 3-phase secondaries of 230, 240, etc. It is highly desirable, in a particular system, to maintain the same stated voltage for lamps and appliances; it is less important in the case of larger multi-phase motors and experience has indicated that 3-phase motors rated at 220 volts will perform satisfactorily when supplied at 208 volts.

At the beginning of 1937, lamp voltages in use in America were divided as follows: 110 volts, 1.8 per cent; 115 volts, 52.1 per cent; 120 volts, 46.0 per cent; all other voltages 0.1 per cent. The prevalence of 120 volts has been increasing rapidly and it is estimated that more than half of the lamp voltages are now 120 volts.

Various regulations affecting distribution are applied by regulatory authorities but the basic standards from which the regulations are derived are, in nearly all cases, formulated by non-governmental bodies, in general by the industries themselves. Thus the prevailing standard for the safety features of overhead or underground distribution circuits is the "National Electrical Safety Code" which, although sponsored and published by the National Bureau of Standards, a governmental institution, is actually formulated and revised from time to time by a committee composed of representatives of the utilities and industrial groups as well as governmental bureaus, etc., all on a basis of equality in voting. This standard by itself has no force, but it is extensively used as a source for the orders of state regulatory commissions, and sometimes by municipal local authorities.

House wiring is extensively regulated, probably in excess of the actual necessities of the case so far as real hazards are concerned. The reasons for this is that it has proved to be difficult to formulate regulations, which really apply to the lay public, without affecting the various commercial interests involved. The effort to maintain an even hand in this respect has resulted in an extremely long, detailed and inelastic set of regulations. These regulations, however, work reasonably well in practice although they have unquestionably tended to retard development and to discourage the application of engineering principles. The actual standard is the "National Electrical Code" which was originally formulated by fire insurance underwriters for their own protection. It is still sponsored and published by the fire insurance underwriters but is actually revised biennially by a committee representing the various interests concerned. Unlike the "Safety Code" the "National Electrical Code" has considerable force in its own right as it is applied by fire insurance underwriters to the risks which they insure.

This code has much additional force, however, because, having been in existence through various revisions for about forty years, and having great prestige and general currency in spite of its defects, it is almost universally used as the model for local ordinances, which apply in almost all cities of 100,000 population and upward, as well as in many smaller places.

The Public Utility Commissions of the various states have published orders, from time to time, relating to voltage regulation, permissible departures from standard voltage, interruptions to service, and, more extensively, to methods of meter testing and maintenance of meter accuracy. Since the commercial practices of the supply companies are almost invariably of a higher standard than these regulatory requirements, they are very rarely invoked, and, as a practical matter, they exert very little influence on design or operating practices.

APPLICATION OF ELECTRICITY

Historical

The incandescent lamp introduced household electric service and remained practically the sole household use for nearly twenty years. The flatiron began to be a factor about 1900. The first vacuum cleaner was introduced about 1902 but became more of a factor in 1910 when a motor driven brush was

introduced in the appliance. The cleaners placed on the market in 1922 showed a decided improvement and received wide public acceptance. The electric washing machine was introduced in 1906. There were substantial improvements in 1911, 1914 and at subsequent intervals thereafter. The electric range became a factor about 1910. The electric refrigerator was first introduced about 1913, the ironer in 1917. Electric clocks came on the market in 1925, electric motor driven oil burners for house heating about the same time, and A C radio sets followed shortly thereafter. During all this time a long list of smaller appliances were being introduced to the market and were improved from time to time. A recent development of value as an electricity consuming appliance has been the electric roaster with thermostatic and time control. The latest important application of electricity in households has been the introduction of air conditioning which may be separated into air cleaning, air circulating, humidifying or dehumidifying, and air cooling.

An estimate of the energy which is consumed by the more important household appliances in the average American home and the percentage of the saturation of these appliances is given in Table IV. Figure 3 shows their consumption of electricity over a period of years from 1920 to 1937. Table V gives an estimate of the number of appliances sold and the average price of such appliances from 1920 to 1930. This table indicates the relation which exists between volume of sales and unit prices.

A comprehensive list of applications of electricity in the home is set forth in Appendix I. (To appear in next issue.)

Lighting

So long as the relatively inefficient carbon lamp was the competitor with gas lighting, the growth of household consumption of electricity was comparatively slow. The production in 1907 of new types of lamps with metallic filaments and of the tungsten lamp introduced in 1911 gave a new impetus to lighting. A present day incandescent lamp of equal wattage gives ten times the light that Edison's original lamp gave. In 1922 a million lumen hours of light as produced by a 60 watt incandescent lamp cost approximately $9.50. At the present day this cost is about $3.60. This reduction is accounted for as follows: 40 per cent due to the increased efficiency of the lamp in fifteen years, 10 per cent due to the fact that the price of the lamp has been reduced from 45 cents to 15 cents in retail stores, and 50 per cent due to the reduction in the cost of electricity.

The use of electricity for household lighting has increased very substantially during the past two years. The Better Light—Better Sight Sales Program in which not only the electric industry has been participating, but the medical profession, paint manufacturers, and others, has helped to introduce much more effective use of light in American homes and a much larger supply of it. Some 5,000,000 portable lamps built on IES (Illuminating Engineering Society) specifications for illumination requirements have been sold in the past three years. These are all of the indirect type and the majority use 2-filament bulbs of 300 watts maximum. They provide for reading purposes an illumination of 20 to 40 foot-candles intensity and serve to establish much higher standards for home illumination. There is still room for vast improvement in the illumination of homes and the sales of electricity for this purpose

TABLE IV—ENERGY USED BY DOMESTIC ELECTRIC APPLIANCES[1]). AN ESTIMATE FOR THE YEAR 1937

APPLIANCE	Approximate number of appliances in homes				Kwhr per year per appliance, normal use	Per cent in normal use	Effective kwhr per year per appliance	Total kwhr used in 1937
	On Dec. 31, 1936	On Dec. 31, 1937	Saturation %	Average 1937				
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Lighting and miscellaneous uses (per cust. 288 kwhrs)								6,365,825,000[2])
Refrigerators	9,200,000	11,300,000	50	10,250,000	420	90	375	3,843,750,000
Radios (socket sets)[3])	21,750,000	23,750,000	106	22,750,000	100	80	80	1,820,000,000
Ranges	1,450,000	1,775,000	8	1,612,500	1,200	85	1,020	1,644,750,000
Flatirons	21,750,000	23,100,000	103	22,425,000	80	80	64	1,435,200,000
Water heaters (all types)	432,000	528,000	2	480,000	3,300	75	2,500	1,200,000,000
Oil burners[4])	1,175,000	1,360,000	6	1,267,500	250	95	237½	301,050,000
Washing machines	10,300,000	11,050,000	49	10,675,000	30	80	24	256,200,000
Vacuum cleaners	10,575,000	11,175,000	50	10,875,000	24	85	20	217,500,000
Toasters	10,250,000	10,500,000	47	10,375,000	30	50	15	155,625,000
Electric clocks	10,300,000	11,500,000	51	10,900,000	15	95	14	152,600,000
Ironing machines	1,175,000	1,315,000	6	1,245,000	125	80	100	124,500,000
Percolators	6,000,000	6,000,000	27	6,000,000	36	50	18	108,000,000
Space heaters	4,500,000	4,750,000	21	4,625,000	50	40	20	92,500,000
Roasters	375,000	650,000	3	512,500	250	80	200	102,500,000
Total Appliances								11,454,175,000
Total Domestic Service (old series) (per cust. 805 kwhrs)								17,820,000,000[2])

[1]) "Residential" plus "Farm" Service less irrigation.
[2]) Preliminary figures.
[3]) Radios (socket sets)—Radio receivers supplied from a socket connected to house wiring.
[4]) Oil burners—For house heating.

Notes: Columns (1) and (2): Estimates largely from ratios shown in "Electrical Merchandising" and other trade papers; being based upon the summation of annual sales of appliances less an estimated replacement demand. Column (4): The arithmetical average of columns (1) and (2). Column (6): An estimate allowing for duplicate and unused appliances, houses unoccupied, summer cottages, vacation periods, etc. Column (7): The product of Columns (5) and (6) representing the actual kwhr per year per average appliance in the home. Column (8): The product of Column (4) and Column (7).

are expected to increase for many years to come.

Room Heating and Water Heating

The use of electricity for room heating, although introduced thirty or forty years ago, has made little progress in the United States. Some use is made of it on the Pacific Coast, where the climate is more equable than is the case in other parts of this country, and some use of it made more extensively during in between seasons to take the chill from a room, particularly a dressing room or bathroom. In general, the extremes of temperature in the United States are such that the home of people who could afford to use electricity for room heating are well provided with central heating systems supplying heat throughout all or most of the rooms of the house. The prices of coal, gas or oil are such as to render electric heating uneconomical in competition with these other forms of heating. The introduction of automatically controlled gas and oil house heating systems has restricted if not actually reduced what use of electricity for room heating had already been made.

Hot water heating has made limited progress in the United States for the basic reasons given for the little use of electricity for room heating. In the Pacific Northwest, where cheap water power has been available and fuels have been relatively more expensive, electric water heating has made more progress than elsewhere. This is also true in the immediate vicinity of Niagara Falls. The introduction of off-peak water heating rates, the improvement in, and the reduction in price of, water heaters, combined with organized sales campaigns, have brought a substantial increase during the past four years in the use of electricity for water heating. The saturation of electric water heaters at the present time is about 2 per cent.

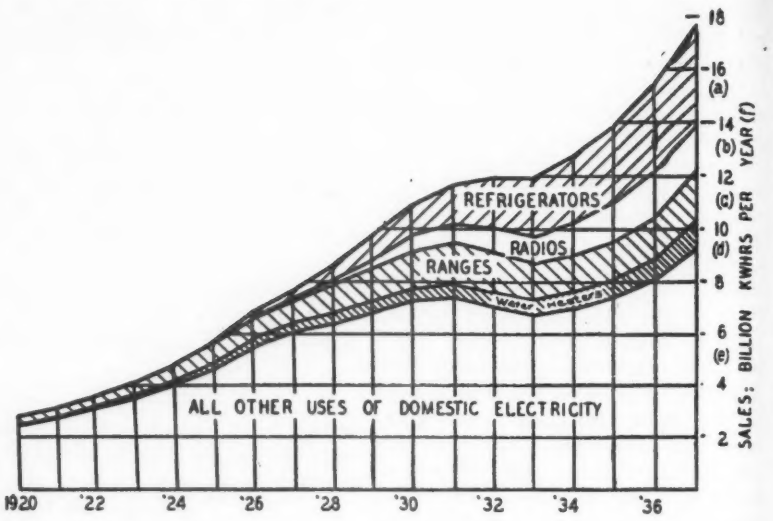


Fig. 3—Domestic electric appliances. Kilowatthours used by various appliances in domestic electric service since 1920. (This chart shows the cumulative effect of the increase in the number of consumers as well as the increase in the number of appliances per customer).

Cooking

The growth of electric cooking, in most sections of the United States, has made comparatively slow progress, be-

TABLE V—ELECTRIC APPLIANCE SALES AND VALUES[1])

Year	Flat irons		Electric clocks		Vacuum cleaners		Radio sets[2]) all types incl. automobiles		Washing machines		Oil burners		Ranges		Refrigerators		Water heaters (Storage type)	
	No. sold	Av. price	No. sold	Av. price	No. sold	Av. price	No. sold	Av. price	No. sold	Av. price	No. sold	Av. price	No. sold	Av. price	No. sold	Av. price	No. sold	Av. price
		$		$		$		$		$		$		$		$		$
1920	2,500,000	7.00	.....	.....	900,000	50.00	.....	.....	600,000	120.00	.....	.....	40,000	.....	.....	.....	.....	.....
1921	.....	.....	.....	.....	600,000	31.67	.....	.....	289,000	135.54	.....	.....	30,000	.....	5,000	550.00	.....	.....
1922	3,300,000	6.06	.....	.....	800,000	50.00	100,000	50.00	422,927	153.69	.....	.....	40,000	.....	12,000	525.00	.....	.....
1923	2,000,000	6.00	.....	.....	1,016,301	63.76	250,000	60.00	554,381	138.99	.....	.....	43,000	.....	18,000	475.00	.....	.....
1924	2,150,000	5.72	.....	.....	903,364	67.44	1,500,000	66.67	612,084	142.14	.....	.....	44,500	.....	30,000	450.00	.....	.....
1925	2,750,000	5.82	.....	.....	970,000	61.86	2,000,000	82.50	736,000	140.63	.....	.....	85,158	175.75	75,000	425.00	.....	.....
1926	3,000,000	5.33	90,000	25.00	1,065,000	61.03	1,750,000	114.29	843,685	146.97	75,000	742.00	110,000	150.00	205,000	390.00	.....	.....
1927	3,000,000	4.75	95,000	26.32	1,194,614	49.00	1,350,000	125.00	775,661	143.01	81,000	750.00	102,972	160.62	375,000	350.00	15,000	125.00
1928	3,000,000	4.58	130,000	30.77	1,219,460	50.00	3,281,000	118.26	809,884	133.35	110,500	700.00	135,000	164.26	535,000	334.00	20,000	125.00
1929	3,150,000	4.58	400,000	20.00	1,253,202	50.00	4,438,000	133.41	956,000	112.87	119,900	611.00	152,781	165.40	778,000	292.00	25,000	125.00
1930	2,362,500	4.60	1,400,000	10.83	960,343	55.00	3,827,800	86.79	802,000	104.50	118,650	550.00	180,000	150.00	791,000	275.00	27,000	130.00
1931	2,150,000	4.65	2,800,000	6.50	686,648	50.00	3,420,000	62.00	812,000	85.00	94,675	525.00	115,000	165.00	906,000	258.00	23,000	135.00
1932	1,850,000	3.85	2,400,000	5.00	447,056	40.00	2,620,000	47.66	569,830	59.00	77,950	482.00	60,000	150.00	798,000	195.00	14,000	125.00
1933	2,430,400	3.54	2,000,000	6.00	547,536	50.00	3,806,000	34.39	966,698	62.00	85,100	394.00	50,000	142.00	1,016,000	170.00	13,000	115.00
1934	4,000,000	3.32	2,100,000	6.29	722,367	54.99	4,084,000	36.94	1,121,137	65.00	103,350	345.75	123,000	130.00	1,284,000	172.00	32,000	105.00
1935	3,700,000	4.00	2,300,000	6.24	906,049	55.67	6,107,000	49.32	1,228,774	65.00	165,000	346.25	215,000	127.00	1,569,000	166.00	70,000	77.00
1936	3,765,000	4.42	3,000,000	4.00	1,150,600	54.27	8,825,000	57.00	1,525,000	66.00	225,000	335.50	318,000	130.00	2,080,000	164.00	104,000	73.00
1937	4,040,000	4.63	3,000,000	4.00	1,313,000	54.25	7,631,000	53.00	1,480,000	71.75	224,000	336.00	405,000	134.00	2,320,000	173.00	115,000	82.60

[1]) All figures taken from "Electrical Merchandising" compilations except those for Water Heaters, which are estimates.
[2]) The figures for Radio sets cover all types — Socket type sets first came into commercial use in 1926, the estimates for this type follow: 1926 — 250,000, 1927 — 600,000, 1928 — 2,700,000, 1929 — 3,800,000, 1930 — 3,272,000, 1931 — 2,912,000, 1932 — 2,127,000, 1933 — 2,732,000, 1934 — 3,064,000, 1935 — 3,450,000, 1936 — 5,360,000, 1937 — 6,100,000.

TABLE VI—ENERGY (EXCLUSIVE OF MANUAL LABOR) CONSUMED IN UNITED STATES HOMES—1936

			B.t.u.	B.t.u.
Bituminous coal	100,000,000 short tons	at	13,100 per lb.	2620×10^{12}
Anthracite	40,000,000 short tons	at	13,600 per lb.	1088×10^{12}
Fuel oil	1,500,000,000 U. S. gallons	at	142,850 per gal.	185×10^{12}
Wood	32,000,000 cords	at	5,000 per lb.	640×10^{12}
Gas (manufactured)	275,000,000 MCF	at	550 per cf.	151×10^{12}
Gas (natural)	325,000,000 MCF	at	1,065 per cf.	346×10^{12}
Electricity	15,650,000,000 kwhr	at	3.412 per kwhr	53×10^{12}
			Total...	5083×10^{12}

Of which:

Bituminous coal	51.6%	
Anthracite coal	21.4%	
Total Coal		73.0%
Fuel oil	3.6%	
Total Mineral fuels		76.6%
Gas (manufactured)	3.0%	
Gas (natural)	6.8%	
Total Gas		9.8%
Wood		12.6%
Electricity		1.0%
		100.0%
Number of homes		32,000,000
Annual B.t.u. per home		160,000,000

Sources:

Bituminous coal; estimated by subtracting all other known uses from total production, by W. M. Carpenter, Economist, Edison Electric Institute.
Anthracite: ditto.
Wood: ditto.
Fuel oil: Number of oil burners at 1200 gallons per year.
Gas: American Gas Association.
Electricity: Edison Electric Institute.

Notes:

Short ton (2000 pounds = 0.9071849 metric ton.
U. S. gallon (231.0 cubic inches) = 0.0031845 kilolitre.
Cord (128 cubic feet = 3.6245 cubic meters.
B.t.u. (British Thermal Units) = 0.2520 kilogram-calorie.
MCF = 1000 cubic feet.

cause of the relatively high cost of purchasing, installing, and operating electric ranges as compared with cooking with gas, coal, wood, or oil, and also because many households depend upon the cook stove for heating the kitchen during cold weather. The prevalence of cheap fuels has provided severe competition. In the average home the combined cost of electricity for lighting and for the operation of motor driven appliances and of gas for cooking and water heating is substantially less than the electric bill for these services, even in areas favored with the very lowest electric rates. This factor largely accounts for the comparatively slow progress that has been made to date. During the past few years substantial progress has been made in the sale of electric ranges and a well organized sales program, national in extent, is helping to bring about a further increase in the number of electric ranges in use. Notwithstanding the increased numbers in use, however, the total kilowatthour consumption for this purpose has remained about the same for several years. This is due to the increased efficiency of electric ranges, automatic control features, and to the changing characteristics of the people. Families have become smaller and they eat less food requiring heavy cooking. They buy more of their bread and cake from grocery stores and bakeries instead of baking it at home. The estimated electricity consumption for the average range has dropped from 1800 kilowatthours per annum in 1916 to 1200 kilowatthours per annum for the automatic type range in 1937.

The small electric roaster using 1000 to 1200 watts, provideed with thermostatic and time clock control and large enough to contain three dishes of food, although introduced only two years ago, has proven popular and its sales are expanding rapidly.

Refrigerators, Radios, Electric Clocks

The electric refrigerator, which began to sell in volume in 1926, has now reach a saturation of 50 per cent. The saturation of refrigerators on a customer basis is only slightly higher in the southern than in the northern sections of the country. The increase in saturation has partly been offset by the increased efficiency which has reduced the annual consumption of electricity per refrigerator.

The saturation of radio sets has attained 106 per cent; that is, some customers have more than one set. The small, low cost radio has been an important factor in increasing the consumption of the customers in the lower income classes.

Electric clocks, which began to sell in volume in 1930 have now reached a saturation of 51 per cent.

Air Conditioning

Because of its cost, air conditioning as yet has been introduced in only a limited number of homes. Air conditioning in commercial and industrial fields has already produced, on some power systems, summer peak demands equal to, or greater than, winter peak demands. It is estimated that between 15,000 and 20,000 kw of air conditioning equipment have been installed in households. A majority of this is in new homes of the wealthier people. This amount, however, promises to increase rapidly because of the physical comfort air conditioning affords. Houses are air conditioned for all seasons, summer and winter.

In the southern states of this country, particularly within the great Mississippi Valley, attic ventilation as a means of cooling houses has made substantial progress because of its material effect in lowering house temperatures, particularly in the evening, and because it is not so costly as other means of cooling. A large ventilator is installed under the roof of the house to draw air through the various rooms at a rate to provide a cooling breeze.

A very recent development which is promising as a means of building up household consumption of electricity is an electrostatic dust precipitator which requires for operation but a few watts, about 40 per room, and removes all smoke and dust particles.

Electricity in Relation to the Total Consumption of Energy in Homes

Heating constitutes the principal energy requirement in American homes. The manual labor performed in the house, although troublesome and tedious, if measured in terms of kwhr or British Thermal Units, consumes a small amount of energy compared with the heat energy that is consumed in the

average home. Electrical energy, although it has now reached a level of 800 kwhr per consumer per annum, equals only 1 per cent of the total energy consumption of the average household, exclusive of manual labor. Table VI and Figure 4 show the estimated coal, gas, wood, oil and electricity household consumption in the United States.

RATES AND SCHEDULES

Promotional Type Rates

For the past twenty years there has been a trend toward promotional type rates. At present, practically every company has one or more domestic rates of this type. Because of promotional rates, over 80 per cent of the household customers now have available a rate of 3 cents or less per kwhr for electric cooking and more than 40 per cent have available a rate of 1.25 cents or less for electric water heating. The growth of the application of promotional type rates is well illustrated by Table VII, which, for fifty-one of the larger cities in the United States, for a period of thirty-two years, shows the average monthly bill for 25, 40, 100 and 250 kwhr use of electricity per month. The promotional character of rate schedules for household service is also illustrated by Table VIII, derived from a rate survey of the Federal Power Commission made in 1935. This table shows the average cost to the household consumer at that time for an initial block of electric energy, and the cost for various additional blocks of energy thereafter. It shows that, although the average charge in 1935 for the first 25 kwhr per month was 8.9 cents per kwhr, it was only 1.7 cents after 250 kwhr were used.

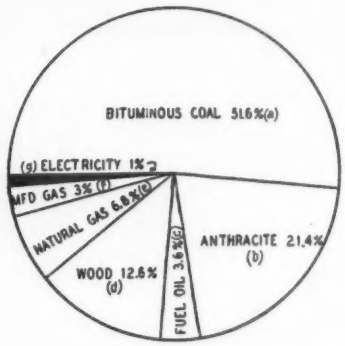


Fig. 4—The energy supply of average household of the United States in 1936.

TABLE VIII—CHARGES BY SUPPLY COMPANIES FOR ADDITIONAL USE OF ELECTRICITY HOUSEHOLD SERVICE

Amount of electricity	Monthly Cost	Cents per kwhr
	$	
First 25 kwhr.....	2.10	8.9
Next 15 "	0.93	6.2
" 60 "	2.30	3.8
" 50 "	1.55	3.1
" 100 "	2.33	2.3
" 250 "	4.17	1.7

Source: Derived from Data in Federal Power Commission Electric Rate Survey 1935, Rate Series #2.

Note: This includes practically the entire private industry or 94 per cent of the total.

TABLE VII—AVERAGE MONTHLY BILL (NOT WEIGHTED FOR POPULATION) FOR DOMESTIC ELECTRIC SERVICE IN 51 CITIES OF THE UNITED STATES JANUARY 1, 1906—1938

Year	Average bill 25 kwhr	Average bill 40 kwhr	Average bill 100 kwhr	Average bill 250 kwhr
	$	$	$	$
1906	2.72	4.22	9.84	23.84
1907	2.68	4.16	9.80	23.58
1908	2.62	4.07	9.61	22.91
1909	2.53	3.93	9.30	22.23
1910	2.54	3.95	9.13	22.87
1911	2.43	3.73	8.51	21.18
1912	2.36	3.64	8.27	19.86
1913	2.27	3.49	7.90	19.38
1914	2.28	3.49	7.85	18.93
1915	2.14	3.28	7.27	17.16
1916	2.06	3.15	6.87	15.75
1917	1.98	3.02	6.45	14.67
1918	1.96	2.97	6.16	13.80
1919	2.00	3.02	6.16	13.48
1920	2.01	3.03	6.17	13.49
1921	2.07	3.14	6.32	13.68
1922	2.03	3.08	6.15	13.08
1923	1.99	3.02	6.03	12.72
1924	1.96	2.96	5.80	12.14
1925	1.94	2.93	5.73	11.88
1926	1.92	2.89	5.68	11.64
1927	1.91	2.86	5.58	11.47
1928	1.86	2.76	5.37	10.81
1929	1.82	2.67	5.16	10.39
1930	1.80	2.62	4.99	9.76
1931	1.78	2.59	4.90	9.47
1932	1.76	2.53	4.79	9.08
1933	1.71	2.46	4.69	8.94
1934	1.63	2.39	4.62	8.79
1935	1.57	2.31	4.48	8.42
1936	1.50	2.22	4.27	7.80
1937[1]	1.43	2.12	4.14	7.59
1938[2]	1.40	2.09	4.07	7.38

[1]) U. S. Bureau of Labor Statistics as of Dec. 15, 1936, assumed to be in effect January 1, 1937.
[2]) U. S. Bureau of Labor Statistics as of Dec. 15, 1937, assumed to be in effect January 1, 1938.

The figures in Tables VII and VIII are calculated from rate schedules and should not be confused with actual revenue data. The average revenue and consumption figures for residential electric service for the period 1913 to 1937 inclusive are shown in Table IX. The household consumer in 1927 paid $30.19 for 444 kwhr. Ten years later he paid $34.81 for 793 kwhr. The price paid for the additional 349 kwhr per annum was thus only $4.62, or 1.32 cents per kwhr. Figure 5 shows the reduction in the price of household electricity over a long period of years compared with the change in the cost of living.

Promotional rates combined with intensive electrical merchandise sales programs and the availability of new low cost appliances, particularly the small radio set selling for $5 to $10, have resulted in a reduction in the percentage of customers in the lower use categories. Table X shows two typical household customer analyses, the first in 1929 and the second six years later in 1935.

Except for the minimum bill customers using from 0 to 10 kwhr per month, there has been a substantial decrease in the lower use customers and a corresponding increase in the larger use customers.

Relation Between Tariffs, Consumption and Revenue

The past decade has been remarkable for the public acceptance of two elec-

TABLE IX—RESIDENTIAL ELECTRIC SERVICE AND COST OF LIVING
Source: Supplement to E. E. I. Statistical Bulletin #4
(Covering Final 1936 Data and Estimated 1937 Data)

Year Dec.	Average annual use kwhr	Average annual bill Dollars	Average revenue per kwhr Cents	Index numbers — 1913 = 100	
				Cost of living[1]	Residential electric service
1913	264	22.97	8.70	100.0	100.0
1914	268	22.25	8.30	102.7	95.4
1915	260	20.80	8.00	104.7	92.0
1916	265	20.15	7.60	116.6	87.4
1917	268	20.15	7.52	138.3	86.4
1918	272	22.50	8.27	166.9	95.1
1919	293	22.55	7.70	191.4	88.5
1920	339	25.25	7.45	195.6	85.6
1921	347	25.65	7.39	174.9	84.9
1922	359	26.50	7.38	170.3	84.8
1923	368	26.50	7.20	174.7	82.8
1924	378	27.25	7.20	174.3	82.8
1925	398	28.90	7.30	181.3	83.9
1926	428	29.87	6.98	178.3	80.2
1927	444	30.19	6.80	175.0	78.2
1928	460	30.36	6.60	173.2	75.9
1929	499	31.44	6.30	173.7	72.4
1930	543	32.58	6.00	163.6	69.0
1931	578	33.18	5.74	148.3	66.0
1932	597	33.25	5.57	133.5	64.0
1933	595	32.67	5.49	134.6	63.1
1934	624	33.07	5.30	137.8[2]	60.9
1935	672	33.53	4.99	141.7[3]	57.4
1936	727	33.81	4.65	143.6[4]	53.4
1937	793	34.81	4.39	148.2[5]	50.5

[1] U. S. Bureau of Labor Statistics.
[2] November 15, 1934.
[3] January 15, 1936.
[4] December 15, 1936.
[5] September 15, 1937.

TABLE X—TYPICAL RESIDENTIAL CUSTOMER ANALYSIS

Consumption kwhr per month	1929 W. M. Carpenter, N.E.L.A. Bulletin, Nov. 1930		1935 E. S. Zuck, U.G.I. Electrical World 2-15-36		Change	
	per cent of customers	per cent of kwhr	per cent of customers	per cent of kwhr	per cent of customers	per cent of kwhr
0— 10	8.4	1.3	8.16	1.18	−0.24	−0.12
11— 20	21.8	8.2	17.16	5.98	−4.64	−2.22
21— 30	22.3	13.5	18.66	10.37	−3.64	−3.13
31— 40	16.3	13.7	15.18	11.65	−1.12	−2.05
41— 50	10.6	11.5	10.64	10.45	+0.04	−1.05
51— 70	10.0	13.9	12.49	16.06	+2.49	+2.16
71—100	5.6	11.3	9.44	17.01	+3.84	+5.71
Over 100	5.0	26.6	8.27	27.30	+3.27	+0.70

TABLE XI—TREND AWAY FROM AREA OR ROOM BASIS FOR RATES

Number of companies having area basis rates		Number of companies having room basis rates		Total number of companies in rate book	
1933	25	1933	115	1933	296
1934	21	1934	110	1934	274
1935	12	1935	83	1935	276
1936	9	1936	58	1936	273
1937	6	1937	44	1937	267[1]

[1] Reduction in number of reporting companies is due to consolidations.

trical appliances, the radio and the electric refrigerator, whose influence on the domestic load has been very large. Beginning with a negligible amount in 1927, the electricity consumed by these two devices ten years later constituted almost one-third of all electricity used in the home. On a per customer basis the radio had added 79 kwhr per year and the refrigerator 157 kwhr, making a total of 236 kwhr per year per customer. This accounts for two-thirds of the entire growth of 364 kwhr per customer during the past decade.

The introduction and public acceptance of electrical appliances in the past twenty years, particularly in the past ten, has confused many into assuming that any reduction in rates is automatically followed by increased consumption which more than offsets any loss of revenue. It is clearly evident that electric rates have had little to do with the sales of radios and electric refrigerators. These have been purchased in huge numbers because of their inherent attractiveness to the public, not because of the cost of the small amount of electricity required to operate them. On the other hand, the increase in the use of electricity which has followed their purchase, due to the promotional character of existing rates, has had the inevitable effect of lowering the average cost per kwhr and so has given an appearance of fictitious reality to the theory that rate reductions are automatically offset by increased use. The Better Light—Better Sight Campaign and the improved and cheaper lamps placed on the market, and the active promotion of the electric water heater have also contributed substantially to the increased use of electricity per household customer.

A controlling factor in the development of domestic electric service is the income which the consumer has to devote to the purchase, maintenance, and repair of electrical appliances. As the national income has dropped, the purchase of electrical appliances has likewise dropped, only to be followed by increased buying as soon as more money has become available to the average man. An increased use of electricity, of course, follows the purchase of these electrical appliances.

While it is true that a reduction in rates tends to increase the use of electricity, this is a minor factor compared with the factors of availability at attractive prices of desirable electrical ap-

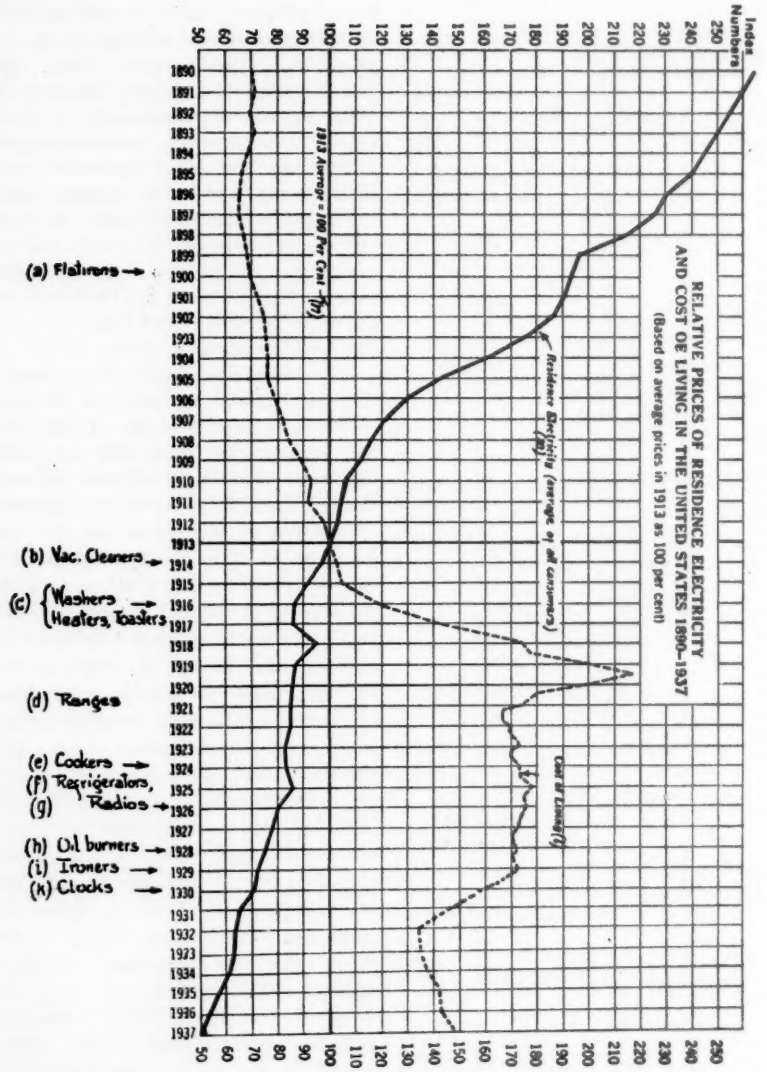


Fig. 5—Relative prices of residence electricity and cost of living in the United States, 1890-1937. (Based on average prices in 1913 as 100 per cent.)

pliances and the purchasing power of the average man.

Development of Forms of Tariffs

The Edison Electric Institute Rate Book covers cities and towns with an aggregate population of 56,000,000 inhabitants. An analysis of the new and revised residential rates reported during 1936 showed that of 133 such new and revised rates, the rate forms were divided as follows:[1]) Straight-line, 9; block meter, 89; hours use (Wright), 16; service charge, 8; demand-energy (Hopkinson), 11; total 133.

There has been a marked tendency toward the block meter type of rate and away from rates with an area or room basis. This is shown by the analysis just given. Table XI shows the trend away from area and room basis rates from 1934 to 1937.

[1]) Explanation of the terms used.

Straight Line Meter Rate. The term "Straight Line" indicates that the price charged per unit is constant, i. e., does not vary on account of an increase or decrease in the number of units.

Block Meter Rate. The term "Block" indicates that a certain specified price per unit is charged for all or any part of a block of such units, and reduced prices per unit are charged for all or any part of succeeding blocks of such units, each such reduced price per unit applying only to a particular block or portion thereof.

Wright Demand Rate. The term "Wright Demand Rate" applies to that method of charges which was the first to recognize load factor conditions and in which the demand costs were included in an initial high rate per kwhr, applicable to a certain number of hours' use of a customer's load, all excess kwhr being at a lower rate.

Hopkinson Demand Rate. The term "Hopkinson Demand Rate" applies to that method of charge which consists of a Demand Charge, a sum based upon the demand either estimated or measured, or the connected load, plus an Energy Charge, a sum based upon the quantity of energy used.

Service or Customer Charge. The "Service Charge," also known as "Customer Charge"—is a component part of a rate schedule providing that a customer must pay a certain definite sum in a specified period (usually one month), without regard to the consumption of energy or the demand, for which he can use no energy or demand.

(This paper to be concluded in next issue)

Nation-Wide Home Lighting Promotion to Be Launched Early Next Year

A NATION-WIDE opportunity to cash in on the home lighting market early next year will be presented about December 1 to manufacturers, distributors, dealers and utility companies throughout the country.

The program is intended to cover the entire field of new and varied types of home lighting equipment, including portable lamps, fixtures, adaptors, and so forth. Available for the promotion will be the new "Prize Award" IES lamps and many other recent developments in the home lighting field.

The campaign was initiated in June through the appointment by Edison Electric Institute of a Special Lighting Committee, with Fred S. Dewey, Cincinnati Gas & Electric Company, as Chairman. This Committee, at a recent meeting in New York, appointed a Plan Committee to outline a "Suggestion Book" and other promotional material which may be used locally to stimulate sales.

Probable date for opening the campaign will be February 1. Complete details of the program, however, will be available two months ahead of time, so that local groups will have plenty of time to prepare their own plans for participation in the national activity.

Experience of many promoters of lighting equipment sales during the past four years indicates that the long evenings of the winter months, and on into early spring, find the public more receptive to lighting promotions than at any other time, and that during this period better lighting equipment can be sold in extensive volume. This Committee proposes to present suggestions that will stimulate participation by all sellers of all kinds of lighting equipment in all sections of the country.

The Plan Committee, which is now at work on the Plan Book and other material, consists of Harry Restofski, West Penn Power Company, as Chairman; R. S. Bell, Commonwealth & Southern Corporation; H. H. Dinkins, Jr., Ebasco Services, Inc.; J. F. O'Brien, Westinghouse Electric & Manufacturing Company; and E. D. Stryker, General Electric Company.

The Expanding Horizons of Man-Made Lighting

New Standards of Illumination and the Enlarging Fields of Usefulness for Radiant Energies

By Samuel G. Hibben

Director of Applied Lighting, Westinghouse Electric and Manufacturing Company

A paper presented before the Vienna Sectional Meeting of the World Power Conference, Vienna, Aug. 25-Sept. 2

IN the fourteen years since the first Plenary World Power Conference, the standards of artificial lighting have moved upward both as to quantities of illumination as evaluated in lux or foot-candles, as well as radical improvements in quality as measured by reduced glare, better control of flux and a wider choice of tints and colors. One index of an improvement in the scale of human living is recorded in the more liberal acceptance of illumination as an important component part of healthful living; of safer traveling; of lessened hazards and of more productive labor—in fact the increase of man's knowledge and the very lengthening of life itself.

Demonstrations of the influence of a more liberal usage of lighting power were presented to the Third World Power Conference, Washington, 1936. Further trends are surveyed herein.

Illumination Values Recently Doubled

A decade ago, in the United States for example, it was rare to find the artificial lighting of school rooms to exceed an average of 5 foot-candles (54 lux) whereas today a minimum recommendation for classrooms has been placed at 15 foot-candles (161 lux) and actual practice in the case of new installations has frequently attained and surpassed an average of 20 foot-candles (215 lux).

Similar changes apply to other types of installations, such that it would be conservative to state today that the average visual task is being performed under approximately twice the illumination of ten years ago, and for many exceptional tasks there are fundamentally sound data to prove that in excess of 100 foot-candles (1076 lux) are frequently advisable.

Factors in Lighting Education

The recent background of education and research that has influenced consumption of electric power for lighting purposes has consisted chiefly of the so-called Better Light—Better Sight movement in America, coordinated with the establishment of lighting service departments of private utilities, of lighting educational bureaus by industry groups, and by a wealth of printed pamphlets.

Issuance of industrial and school lighting codes of mandatory flavor has been favored, plus such additional incentives as a continually lowering cost of electric power for lighting, and of incandescent lamp bulbs and similar light sources.

Some four years ago (May, 1934) the (American) Illuminating Engineering Society developed and sponsored a certified design of table reading lamp, later extended to floor pedestal lamps, and inaugurated an approval testing system for all variegated models as made by any manufacturer but to the end that all lamps that met the strict requirements for lighting and mechanical satisfaction should be patently so marked by an I.E.S. "approval" tag. To date in excess of 3,000,000 such approved lamps have been placed in service, representing largely additional kilowatt-hour load and averaging in excess of 100 watts per unit.

Criteria of Lighting Standards

The criteria upon which better lighting has been predicated is well expressed by the following tabulation:

Criterion	1 Foot-candle	10 Foot-candles	100 Foot-candles
Visual acuity—basic factor in reading	100%	130%	170%
Contrast sensitivity	100%	280%	450%
Nervous muscular tension while reading	63 Grams	54 Grams	43 Grams
Frequency of blinking after one hour's reading	100%	77%	65%
Rate of heart pulsation while reading for one hour	10% decrease	—	2% decrease
Convergence reserve of ocular muscles after one hour's reading	23% decrease	—	7% decrease

Some further ideas of recommended foot-candle or illumination values (on the object) in typical American practice are represented in the following listing:

Automobile Show Rooms	20
Drafting Rooms—Detail	30 to 50
Hotel Lobby	10
Hotel Corridor	2
Office Bookkeeping	30
Professional Offices	20
School Auditorium	10
School Classroom	20
School Sewing Room	50 to 100
Show Windows	100 to 200
Railway Coach	15
Depot Concourse	5
General Manufacturing	10 to 20
Photography	2000
Badminton Court	30
Tennis	20 to 30
Loading Docks	5
Storage Yards	1 to 2
Railroad Yards	0.2
Building Exteriors	5 to 20

(Multiply by 10 to translate to approx. Lux)

The Growth of Lamp Consumption

All arguments point toward a continually growing appreciation and usage of artificial light, with corresponding although not parallel rate of growth in kilowatt-hour consumption. Differences of course may be accounted for by increased efficiencies of light sources, although to date the result of increased efficiencies has always been increased usage and more liberal applications.

One index of the growth of lighting has been the annual numbers of lamps (exclusive of miniature types) that have been sold annually in the United States. The following tabulation records the progress for the most recent five year period.

Year	Average Watts	Average Lumens	Total Large Lamps
1933	58.2	793.0	339,341,000
1934	58.7	809.0	379,684,000
1935	60.4	842.1	413,039,000
1936	61.0	863.4	462,451,000
1937	60.1	880.4	506,666,000

From such data it is obvious that kilowatt consumption has increased enormously. Multiplying the total number of lamps by the average watts per lamp shows an increase of about 50% during this period. Correspondingly the average lumens or quantities of generated light per unit have increased as represented by a growth of 11% from 1933 to 1937. If one were to study the records going back over a 15 year period and were to assume approximately the same increase during the next five years, there would be an expectancy in the United States of a growth in incandescent lamp consumption of between 15,000,000 and 20,000,000 lamps (bulbs) annually.

The Decreasing Power Costs

Contrary to some popular fallacies, there is no dead-lock between reduced prices of lighting and increased consumption of power. Neither one awaits the overtures of the other, but both go hand in hand under the incentive of increased volume of production and consumption, and the developments under privately owned manufacturers and power producing companies. In the decade between 1927 and 1937 the American consumer of domestic electric power for household use found his payments per kilowatt-hour reduced on the average from approximately 6.9 cents to 4.5 cents. For commercial lighting power the reduction has not been so steep but the payment per kilowatt-hour is now in the neighborhood of 3.5 cents and the payment for industrial power is slightly above 1 cent.

Trends of Kilowatt-hour Consumption

It would be somewhat optimistic to record that the kilowatt-hour consumption per wired residence in the United States was doubling every decade but the data shows an increased usage on that order. For instance in 1926 the average American residence consumed 425 kilowatt-hours, this chiefly for lighting purposes. In 1936 the consumption had risen to 711 kilowatt-hours; in 1937 to 793, and for 1938 the estimated figure is 825 to 850 kilowatt-hours. The dilution of the household electric appliance, refrigerator and cooking load into these metered kilowatt-hour figures makes it difficult to specify exactly what the growth of strictly lighting power may be. However, it is safe to say that by 1947 we will expect the average residence in the United States to consume easily 1300 kilowatt-hours annually, or more if the inadequacy of wiring and wire sizes does not retard the normal trend. This consumption applies to some 22,500,000 wired residences today, —probably 25,000,000 in 1947. Farm homes may add over 2,000,000 to these figures.

In the case of the lighting of commercial establishments such as retail stores and office buildings, much the same growth is noted, there being an average of some 4300 kilowatt-hours consumed annually per structure in 1937 and an estimated growth to 5500 kilowatt-hours in 1947.

The growth in industrial electric load is harder to predict and here the percentage used for lighting purposes is a lesser part of the total, so that the index shows but a trend. On the basis of 85,000 kilowatt-hours per factory in 1937, one may conservatively estimate 110,000 kilowatt-hours annual consumption in 1947.

The consumption of electric power in commercial and in domestic establishments, the chief percentage of which is for lighting purposes, has been about equal in the past few years. Each group of consumers is now responsible for annual utilization of approximately 20,000,000,000 kilowatt-hours. Industrial consumers as a group use about three times this total. It has been closely estimated that some 20% of the generated electric power in the United States is employed for lighting purposes and brings to the utility companies some 40% of their total revenue.

The Lessening Costs of Lamps, and of Lumens

Part of the explanation for increased lighting usage is traceable to the continually lessened costs of electric lamp bulbs inasmuch as it has been proven to be good business to lessen cost by mass production and a constant attention to manufacturing efficiencies (rather exclusive of wages) and to then pass on to the consumer the benefits of these reduced costs. The list price of the American-made 60 watt Mazda lamp is illustrative and in accordance with the table shown below.

Neither has the increased lumen output per lamp been neglected because this 60 watt Mazda lamp that produced less than 500 lumens in 1908 has grown to 550 lumens in 1915, 620 lumens in 1922; 700 lumens in 1930 and some 835 lumens today. Indeed it is not surprising that lighting usage has increased when the customer may procure five times the light for the same cost of three decades ago.

New Light Sources Create Incentive

When surveying general trends it is important to note that during more than 50 years of lighting practice, the practical illuminants were limited to electric tungsten filament lamps and incandescent mantle gas burners. The electric arc lamp played a part but has now diminished to rather limited fields such as motion picture projection, military searchlights, and ultraviolet therapy. During that half century the art and science of illuminating engineering was becoming well founded—scientific hands were becoming expertly trained to handle lighting tools that slowly but surely became sharper and more potent.

Nevertheless there was a certain limitation in the variety of the illuminants;

PERFORMANCE OF THE 60 WATT, 120 VOLT (AMERICAN MAZDA) LAMP

	1907	1927	1932	1937	1938
Lamp List Price	$1.75	$0.25	$0.20	$0.15	$0.15
Initial Lumens	474	672	714	828	834
Cost of Light per million Lumen-hours[1]	$18.68	$7.04	$5.26	$3.65	$3.54

[1] Includes cost of electric energy.

of the qualities of light that could be had, and in the styles of lighting fixtures (luminaires). Recently the first great incentive towards entering a new era of illumination was evidenced by rather radically new styles of lighting fixtures generally classified as architectural or structural units or "built-in" luminaires. Such are the diffusing glass ceilings, coves, panels, luminous soffits, glass blocks, artificial windows, and large low-brightness areas.

Metallic Vapor Discharge Lamps

A second great incentive has been the recent introduction of electric discharge lamps chiefly employing high pressure mercury vapor and sodium vapor. These new tools have incited a renewed interest in highway lighting, with chiefly the 10,000 lumen sodium lamp in America and with somewhat smaller wattage sodium units in western Europe. The mercury vapor lamps in 400 watt, 250 watt, and 100 watt sizes chiefly, have lighted many miles of residential suburban streets in Europe and many of the heavy industries in the United States. An index of the growth of this latter illuminant can be had from the following tabulation:

U. S. Consumption of High Intensity Mercury Vapor Lamps

	Approx. Net Sales	Approx. Number
1936	$310,000	40,000
1937	$525,000	72,000

To date the volume is not large, but the refreshing influence upon qualitative lighting is great.

Admixtures of mercury and filament lamp sources have led to further novel high intensity lighting installations in commercial structures, large public auditoriums, etc., while the distinctive color features—the gold of sodium, and the light yellow-green of mercury—have awakened an increasing interest in decorative floodlighting or building facade illumination and the lighting of outdoor green shrubbery and gardens.

Fluorescent Illuminants—An Intriguing Tool

The lighting industry seems never to remain static, because now the horizon of man-made illuminants is enlarging rapidly with still a third new development, namely, tubular bulbs employing the principle of an interior fluorescent coating. This coating translates the otherwise invisible short-wave radiations (as from mercury vapor) into a variety of pastel tints of visible light. In the United States such illuminants are being introduced under the name of Fluorescent Lumiline lamps, characterized by greatly increased efficiencies of luminous output of colored light; very much less heat; and the emission of qualities of radiation duplicating daylight if needed, or adjusted to the decorative treatments of almost any type of interior. Such illuminants usher in a new era of "painting with light" and bid fair to add luxurious or joyful illumination to the heretofore rather limited prosaic utilitarian lighting.

Characteristics of Fluorescent Illuminants
(American Lamps as of April, 1938)

Nominal Size, Inches	18×1	18×1.5	24×1.5	36×1
Nominal Size, Cms.	45.7×2.54	45.7×3.81	60.96×3.81	91.44×2.54
Lamp Watts	15	15	20	30
Lamp Volts	63	50	65	115
Approximate Lumens per Watt				
White	30	30	32	35
Daylight	30	30	32	35
Blue	18	18	19	21
Green	60	60	65	70
Pink	20	20	22	24
Gold	18	18	19	21
Red	3	3	3	3

Bactericidal Radiators

Allied with the generation of visible light, i. e., radiation included roughly between 4000 and 8000 Angstroms wavelength, there have been recently introduced commercially some types of low pressure mercury vapor sources from which approximately 80% of the energy is emitted in the region between 2000 and 3000 Angstroms and which serve to kill micro-organisms, mold spore, etc., and hence take their place as bactericidal (sterilizing) lamps in man's fight against disease and spoilage. It would be difficult to estimate the effect of such radiators upon electric power consumption but they hold interesting promise, smoothing out the demand curves and permitting electric power to perform another great service in prolonging man's life and lessening his economic losses.

The Inadequacy of Wiring

One dark cloud above the bright and expanding vistas of lighting is the lack of adequate wiring facilities in privately owned structures or the inability of the user to secure the benefits of new illuminants and appliances without paying the heavy penalty of rewiring. In America where the definite tendency is toward country-wide standardization of 120 volt alternating current distribution networks, the standards as to wire sizes have not kept pace with the growing usage of electric power. In fact the universal wire in smaller structures has remained the # 14 B & S gage size (1.6 mm) for several decades. As a consequence, coupled with an inadequate number of attachment points or convenience outlets, the proper usage of portable lighting devices has been restricted and, more regrettably, the ultimate socket voltage has been lowered through conductor resistance to the point where many of the lighting devices are reducing on the order of 10% to 20% less than their normal output—a wastage for which nevertheless the user continually pays.

This menace towards expansion has been recognized by some branches of the industry, and in America a movement is under way through well organized committees to put into practice the standards of wiring adequacy that are based upon present and near-future needs, rather than as in the past upon merely a protection against hazards of overheating.

No Saturation in Sight

Finally, the least optimistic view that can be had of lighting developments, taking into account more adequate service; lowered costs; research for newer and better light sources; more artistic luminaires; more universal knowledge of the needs of the human seeing machine—all such cannot help but disclose a constantly enlarging horizon and the promise of many undeveloped or but partially established standards and quantities of usefulness.

No one can say that any degree of lighting saturation is yet in sight. So long as civilization advances, we cannot expect any early leveling-off of the constantly upward sloping curve of power consumption for lighting purposes.

The Romance of Business

By Dr. Adam S. Bennion

Assistant to President, Utah Power & Light Co.

A talk before the North Central Electric Association, Duluth, Minn.

WHEN you remember *her* anniversary without being reminded—that's romance. When you can play bridge with *her* as a partner and not indulge in a discussion of relative stupidity—that's romance.

But the word has a meaning beyond youthful affection. It is distinguished usually from both classicism and realism. Classicism ordinarily implies order and proportion; romance hints freedom. Realism depicts things as they actually are; romance presents them as they are imagined to be. But over and above all of these distinctions the term "romance" carries with it the spirit of adventure. It is true, of course, that often there is more romance in reality than in fiction. There is romance in life and the fun of living lies largely in keeping that romance alive. There is romance in American business. America was founded on the romantic courage of the men and women who dared to lay our foundations. Won't you be romantic enough now in fancy to imagine that you were among the Pilgrims who landed in Plymouth in 1619. In the spirit of fancy project your romantic vision across 300 years, if you will. Your most romantic conjectures cannot match the realities which have been written into American progress.

That band of 102 Pilgrim souls has become a great nation of more than 130 million. Thirty million families live in American homes valued at 102 billion dollars. Six and one-half million farms are under cultivation at a valuation of 58 billion dollars. American families enjoy 25 million automobiles, 19 million phones, and 30 million radios. They travel on 3 million miles of highway, three-quarters of a million of which are surfaced. Thirty million children are in school in America; 23 million in the elementary school, 6 million in high school, and more than a million in college. Americans have erected public buildings worth 30 billion dollars. Forty-four million Americans have savings accounts of 24 billion dollars, and there are 64 million life insurance policies representing 110 billion dollars of insurance. The American people are served by 250,000 miles of railroad. Our locomotives and cars would form a solid phalanx 5 abreast from San Francisco to New York. The industrial story of America smacks of romance unmatched in the annals of history.

Try to think for a minute of those who share in that romance. The employes alone in American institutions constitute a great army. Note these figures: 275,000 in the American Telephone & Telegraph Company, 260,000 in General Motors, 96,000 in the New York Central Railroad, 122,000 in the Pennsylvania Railroad, 74,000 in the F. W. Woolworth Company, 84,000 in the Bethlehem Steel Corporation. Whether we look at the mills, the factories or the bridges or the memorials we thrill at American achievement. When Old Glory waves, she waves over a great heritage.

I make no undue claims for industry—I am mindful that this good land has been built by five great institutions; the home, the school, the church, the government, industry. Each has made its own unique contribution but certainly pride attaches to the achievements of industry. Business pays the bills. Business largely makes possible the living that goes on in the home, the work that is carried forward in the school, and the inspirational uplift of the church.

If there is romance in this glance at the historical development of industry there is still more of it in the close-up view of present-day business as it is carried forward. So much is involved if business is to succeed. There is the matter of invention—of financing—of organization—of management and of struggle against the hazards of business. Let us look at each of these just for a minute.

What an invention can do in revolutionizing civilization! There are 2 million patents in the United States Patent offices. Of these 1,150 are credited to Thomas A. Edison. Through his inventions alone industries have been set up with an investment of 25 billion dollars, and 2 million jobs have been provided. Invention involves the genius to see with new vision, the travail to give birth to the new idea, and the infinite pains to see the matter through.

Financing is full of romance. Money is naturally timid. If you had a thousand dollars today where would you invest it? Where can you turn to be sure that you will get the thousand dollars back, together with reasonable earnings? Or did you ever try to raise 20 thousand dollars to go into business?

In the matter of organization consider the wisdom needed to set one up—to select the right men, to train and develop them, and build them into a pulling team.

And certainly no one can be in business today and not be aware of the hazards that are involved. Our cities are full of failures. The one item of weather is almost hazard enough. Then there are changes in style and the very real hazard of competition and the problem of uncertain collections and the damage done by shifts in the location of industry.

As I contemplated giving this talk I stepped into one of the large department stores of our city. It handles more than 20,000 different items. It employs a thousand men and women to carry forward its activities.

There is adventure in the shop of the grocerman who must anticipate the needs of the community, who must buy wisely, who must display his wares skillfully, and who must develop the fine art of satisfying his customers.

American business has been built in a spirit of adventure and romance. That spirit still lives but American business stands today at the crossroads. Only intelligent thinking can save us from the catastrophe of collapse or inflation. Won't you kindly take the following ten points or others betters suited to your purpose and solemnly pledge them into the lives of your membership that you may help the people of America to think through our present vexing problems:

1. Without profit no private business can continue to operate. It lies at the foundation of industry.
2. A reasonable profit is the great urge to initiative and to thrift—and is no crime.
3. Forty-eight million working people in America depend upon somebody's payroll. Payrolls can be met only by profit-making industries.
4. Industry needs the cooperation, regulation, and protection of government.
5. The government should be an umpire, not a competitor.
6. The government should withdraw from the field of competitive business in which it

(*Continued on page* 405)

A Look at the Safety Record

By Col. John Stilwell

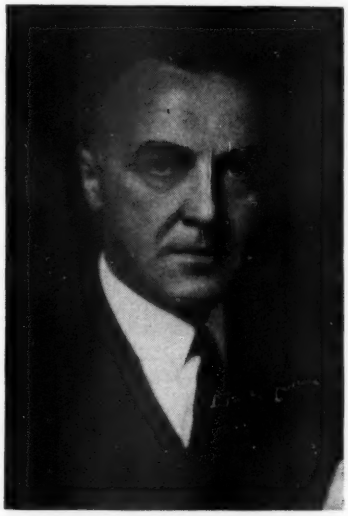
Vice-President, Consolidated Edison Company

An address before the Empire State Gas and Electric Association Convention, Lake Placid, N. Y., Sept. 15, 1938

I HAVE long interested myself in all problems that may affect the relationship between employer and employee, but only in safety work have I found such whole-hearted employee-response, such rich rewards in dollars saved and lives spared, such pleasurable satisfaction with a humane job well done in society's interest. Let me persuade you, gentlemen, that, though the effort be great, you will never regret it; though the earnestness of your initial course may at first meet with some opposition from self-interested sources, you will before long have won the respectful admiration and support of those very dissenters; though the modest needs of safety may appear avoidable expense, you will inevitably return that cost many times over in any single year's dividend from improved accident experience. It is regrettable that all of our safety dividends cannot be more definitely shown—but they are there. I mean not only the dollars but the saving of suffering and increased morale of employees.

The first step in the job is the one you will all find the hardest—finding the man to direct the work. No man can be taken from another job—especially if he has failed in it or done it poorly—and be expected to be an efficient safety man. This has often been done in the past due to a lack of the full appreciation of the value of safety. Invariably such a man is temperamentally if not otherwise unfit to carry on a work so definitely requiring a man of strong dynamic force, liberally endowed with powers of persuasiveness and true leadership. Certainly a weakling cannot command the respectful attention of men of higher position, especially if they are forewarned by knowledge of that weakling's performance in other jobs. If you have allowed yourselves to be persuaded to give the safety direction into such a man's hands, you are licked before you start.

Be sure that your safety engineer reports to the top directly and not through any operating unit. Unless he finds himself in a position of parity with the operating branch all the way from bottom to top, your safety man will soon find he



COLONEL STILWELL

can accomplish nothing without the sanction of the very men whom he must curb in their unsafe course.

Management in industry is charged with many responsibilities of tremendous consequence but none more grave than safety. No longer may he explain away a succession of disasters, or an abnormal number of accidents, with a few words of vain protest at an unkind fate that has gratuitously enveloped him. His world knows too well that accidents do not happen; they are caused, and not entirely by the unfitness or carelessness of the men who are hurt.

The army—that paragon of discipline—tells its officers that they are responsible for the safety of the men under them. We men, too, are officers in an army—the vast army of an important industry—and the men engaged in the gigantic task of generating electricity, manufacturing gas, and distributing both are entrusted to our safe-keeping just as surely as are the plants and other physical properties of our various companies. In so far as we have failed in our duty toward our employees in the vital matter of protecting them against the wanton waste of serious accident, we lay ourselves open to the charge of having been derelict in that duty; and we may well thank our lucky stars that, in this country at least, industry is not governed by so rigorous a discipline as army regulations impose. We might be court-martialed.

Let us look a moment at safety, that we may see just what the nature of our duty in respect to safety is. The risk of fire, explosion, or other disaster to physical properties should, of course, be reduced to its irreducible minimum. Equipment should be, of course, so constructed and installed as to eliminate every avoidable risk of accident to the reasonably careful workmen. There remains, then, only our part—we must teach our employees how to work safely and must see to it that they do work safely.

Give your safety engineer not only the unqualified backing of an executive independent of the operating groups, but also the financial support so deserving a job requires. Let him have a few colleagues to help him educate your workers, and inspect your properties; and give him the cooperation of seeing to it that his reasonable suggestions are promptly complied with. He will soon prove by his results whether he deserves your continued support. Remember always, however, that the safety man must be a super-salesman; if he is the man you want to keep and support, you will find throughout your personnel a general consciousness of his presence, appreciative comment from the great bulk who are benefited, silly criticism from those few with fancied grievances. Should you find your experience otherwise, beware lest you find you have no safety engineer at all and your whole safety effort prove in vain.

If you would know what an efficient safety campaign can accomplish, I point to our own record, my pride in which you will better understand if you will bear with me for just a few moments more.

Our industry is of its very nature a hazardous one, filled in its every operation with the potentialities of frequent and serious accident. In a recent tabulation by the National Safety Council thirty reporting industries are classified as to accident frequency rates per mil-

lion hours worked. Of these tobacco led with the extremely low rate of 2.22, and lumber lumbered along last with 57.29. Our industry stood fifteenth with 12.34 followed only by industries whose record shows them to be habitually among the poorest performers in safety.

Reduced to a ratio of accident incidence by hundreds of employees, our industry's rate comes to 2.55 nationwide. Without the Consolidated Edison group of companies, the rate is 2.75, because that company's low rate of 1.43 brings down the national average to this marked degree. I should like to make the observation that the Consolidated Edison group, although ten years ago worse than the rest of the industry in the matter of accident frequency, has by the adoption of an active safety campaign, placed itself in the lead.

I have mentioned the improvement in our system companies' experience. In 1927, just ten years prior to the last available complete year's experience, we had an accident frequency of 10 per hundred employees; the balance of the industry had an accident frequency of 8.2 for electric, and 8.05 for manufactured gas operations.

Those are the figures, but not all of the record. We can never hope to know how much our safety work among employees has accomplished in the prevention of accident away from plant and distribution operations. Statistics are not available to show how much improvement in non-industrial accident experience results from education of employee personnel; but we have every right to conclude that the diffusion of safety ideas through the community by a well educated and highly trained group of men and women must have its full share of credit for the general reduction of accident frequency. It is entirely fitting that a public utility should be foremost among the leaders in this important civic movement; and you will find that if you make your employees safety conscious, they will quickly earn for your companies the grateful appreciation of the citizens who are your consumers.

In brief summary, gentlemen, the achievement of safety is not difficult—that is, not too difficult to fail to attract even the most hesitant and the most doubting. There are three phases of this work—first, engineering, conducted by competent men to remove physical hazards or invitations to accident; second, education carried on by equally competent though differently trained men to eradicate from the minds of employees any proneness or predisposition to accident; and third, enforcement, the disciplinary arm that must be yours, ready always to chastise too frequent offenders against the planning and teaching of engineer and educator, and equally prepared to bring into line supervisors who for one or another reason will not be cooperative.

The activities of engineer and educator are of necessity most effectively carried on under the general direction of a properly qualified insurance department, because the insurance mind best understands the necessity of reducing insurance costs by the elimination of losses and accidents, and therefore most consistently devotes itself to the improvement of every means of achieving the result that is the fond hope of every insurance man—a perfect experience—one without accident or loss!

Your patience will not permit me to speak as long as I might of what we have done to better our accident record. We have lectures for operating personnel twice yearly, in which by precept and picture, we set forth specific hazards and offer specific remedies. We have safety committees of purely supervisory people at which accidents and responsibility for them are discussed. We use bulletins, of commercial types readily available at reasonable cost, but more often of our own design made by our own people to meet our own problems. We subject our drivers and chauffeurs to periodic medical examination to determine their continued physical fitness, and hold special safety meetings at which problems of traffic and of car operation are painstakingly analyzed. We hale to a court of inquiry any driver who has had an accident, to give him the opportunity of telling what he thinks happened, so that he may be justified, if blameless; criticized, if blameworthy; educated, in either case.

You have noticed, I am sure, that our principal approach to safety is by the gentle method of education. We teach our people to do their work efficiently, offering them a great variety of technical job-training and other courses. We teach them to do their work safely, using every medium and device and method known to us to convey our safety lesson. And, finally, we send them out into the world we serve to show how well they have learned to do their work, and to do it safely. This gentlemen, I believe, is a duty of a public utility—and if we have hitherto learned that one's first duty is to labor honestly for one's bread, let us now learn a duty even higher, to earn it in perfect safety to oneself and to the world.

Torchio Retires from Consolidated Edison

PHILIP TORCHIO, vice-president of Consolidated Edison Company of New York, Inc., retired on August 2, in accordance with the company's 70-year age limit.

A native of Italy, Mr. Torchio began his career with the Edison companies in 1895, when he was employed as a draftsman by the Edison Electric Illuminating Company of New York, predecessor of the New York Edison Company. Four years later he was made statistician, then engineer of economics, engineer of distribution, chief electrical engineer. In 1924 he became vice-president in charge of electrical engineering. At this time he also acted as consulting engineer of the United Electric Light & Power Company, New York and Queens Electric Light & Power Company, Yonkers Electric Light & Power Company, Westchester Lighting Company and the Bronx Gas & Electric Company. Before the merger of the New York Edison and United Electric Light & Power companies into Consolidated Edison Company he was senior vice-president and a director of these two companies.

Mr. Torchio is best known throughout the industry for the work he has done in the development of electricity in steam and hydraulic stations and in the unification of systems of transmission and distribution over large territories.

He originated (and holds a number of patents, here and abroad) various improvements in apparatus, cables, storage batteries and electrical control. During the World War, he was consultant in developing, with the government's representatives, plans for the interchange of electric power between electric companies along the eastern seaboard to meet greatly increased requirements of the war industries. He was also consultant for the Navy Department in the development of electrical cable for use in large, electrically propelled battleships which have power plants of enormous capacity.

Mr. Torchio is a past-president of the New York Electrical Society, fellow of the American Institute of Electrical Engineers, member of the Franklin Institute, Illuminating Engineering Society, Associazione Elettrotecnica Italiana.

Mobilization is the Thing—Mobilization for Sales

By C. E. Greenwood
Commercial Director, Edison Electric Institute

THE same old questions but never in the same old way come before us for review in the Fall of each year when we ask—"What about 1939?" Business of all kinds makes this query as it peers through the clouded outlook of the next few months and wonders what the turn of the year will bring.

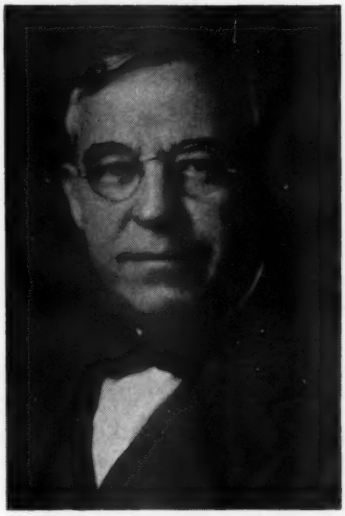
The utilities study the situations in some other industries hopeful for regained loads if there should be a broad pick-up in them. What will be the employment situation which so vitally affects the activities of stores, offices and other commercial establishments and the spending habits of people in the shops and for home services? How true that the energy output record of the utilities is a barometer of all business.

There has been a recent ray of hope in the ability of American business to refuse to take the count any longer. But conditions beyond its control still hold business down and business struggles like the man who has both the referee and umpire sitting on his chest while the count is being taken. The political picture is still oppressive. Federal spending is still rampant without hope of gain from the application of present practices. Incriminations and vindictiveness in Government relations with business continue without rhyme or reason.

And at the time of this writing Central Europe is furnishing spectacular and fearful news for radio broadcasts and for newspaper headlines. We wonder how soon the little international war being waged in Spain by representatives of a dozen nations will be echoed in a greater and more devastating one. Who would care to answer "What about 1939?"

Fortunately the sales-minded cannot entertain the thought of defeat. We have been fighting economic strife so long that we are getting accustomed to it and we must see through the haze as far as we can and pick a course of action even if we may be side-tracked by War as an actuality. Business will go on. We can change the tempo of public buying even in times of stress, and we in the electrical utility industry can do it with good grace because we know that today a kilowatt-hour of electricity, properly put to work, is the best buy that the consumer can make.

There is no thought of curtailing the commercial activities of the Institute but the remolding process in our Committee activities, and in connection with National Programs, will be organized and carried through on an "investment" basis. All activities will be aimed at definite bulls'-eyes.



Introducing
HARRIS E. DEXTER
Chairman, E.E.I. General Sales Committee

Harris E. Dexter Leads General Sales Committee

It was not with a sign of the times in mind that President C. W. Kellogg appointed Harris E. Dexter, Commercial Manager of the Central Hudson Gas and Electric Corp., Poughkeepsie, N. Y., to the important assignment of Chairman of the General Sales Committee. However it is pertinent to point out that in addition to his business qualifications Mr. Dexter has an enviable War record for service. He was Captain of the First Gas Regiment in the 30th Engineers, A.E.F., and by the grapevine route I am told that he was dubbed the most resourceful Captain of the Regiment.

A biographical sketch of Mr. Dexter has already been published in the trade press, yet we would record here that following his graduation from Massachusetts Institute of Technology he was with the General Electric Company in charge of design of magnetic control apparatus. Following his War service he served as District Engineer and Manager for Southern China with Anderson, Meyer & Company, Ltd., agents for International General Electric Company in China. He was consulting engineer for Foochow Electric Company and Fukien Telephone Company and later a member of the Min River Conservation Board.

In 1924 he returned to the United States in consulting and sales work in refrigeration and followed this service for two years as Chief, Electrical Equipment Division, Bureau of Foreign and Domestic Commerce. It was from there that he entered the utility business in 1927 with Central Hudson Gas and Electric Corporation where he has advanced to the position of Commercial Manager. He has been a Director of his Company since 1935.

Mr. Dexter has served as Chairman of Committees of the National Electric Light Association and succeeded Mr. P. H. Powers of Pittsburgh last year as Chairman of the National Electric Water Systems Council.

The writer has followed with interest commercial developments of this "smaller" Combination Company on the Hudson serving the City of Poughkeepsie—the home of Vassar College—and scores of surrounding towns. It represents a cross-section of city, suburban and rural population. Although Mr. Dexter would be listed among the Roman Riders, his Company has a saturation of approximately 23 per cent of electric ranges. In order to sell electricity as a fuel to many of the rural customers who could not afford ranges,

he started out to popularize the roaster with the result that these have been sold to approximately 7 per cent of the rural group during the last twelve months. Electric refrigerator sales for the country during the first six months of this year had an average drop of 45 per cent over the same period of 1937. Mr. Dexter has kept the curve of refrigerator sales upward during this year by using the Meter Method of payments, reducing the purchase price to only two nickels per day. He wants people of all classes to enjoy the benefits of electricity. It is of further interest that in tackling the low income group he determined upon water heating "at the source" as a possible method. Results—the sale of 1½ gallons non-pressure water heaters to 2 per cent of the rural customers in the first nine months of this year. Suffice it to add that Mr. Dexter will tackle his Sales Committee problems this year with interest and enthusiasm.

This being reorganization year the services of new men will be drafted for Committee work. At the present time, Chairman Dexter has continued some of the Committees which have functioned effectively in fact-finding in classified fields. New Committees will be added. At the present time the work has been divided into ten Committees covering the subjects of Lighting Sales, Industrial Power and Heating Sales, Air Conditioning, Electric Cooking, Electric Water Heating, Electric Refrigeration, Commercial Sales, Dealer Coordination, Sales Promotion and Wiring. The personnel of these Committees and the General Sales Committee will be published in a later issue of the BULLETIN.

In addition to the regular organization of the General Sales Committee, National Programs are to be continued and new ones are in process of development. During the marking-time period ground work is being laid for a mobilization of selling forces to forge ahead through the back-wash of economic stress. The road to a healthy business is through the power of the sales force in producing profitable energy sales.

A complete list of all E. E. I. publications will be sent upon application to

EDISON ELECTRIC INSTITUTE

420 Lexington Ave., New York, N. Y.

INDUSTRIAL AND COMMERCIAL CUSTOMER BENEFITS CONTEST

If You Were a Commercial or Industrial Power User, Would You Know All the Reasons

"WHY I GET MY POWER SERVICE FROM A POWER COMPANY"

$300 in Prizes for the Best Answers

1st Prize	$100.00 in cash
2nd "	75.00 " "
3rd "	25.00 " "
and 10 Cash Awards	10.00 each

What Are the Customer Benefits of Purchased Power?

How Many Do You Know?

Present them in your own way. **In tabular form, with one or more short supporting explanations; as an essay; composition; dialogue; straight sales argument—any way you prefer.**

The purpose of this Contest is to mobilize the numerous Advantages of Central Station power for the customer or prospective customer in terms of "Customer Benefits" (either so-called "Intangible Benefits" or actual dollars and cents evaluation of these benefits), as they affect the Prospect's or Customer's particular business. In other words, an interpretation of Power Company service, and its many advantages, in language that a *user* can readily grasp and apply in his own evaluations of the service.

Terms and Conditions

Any person employed by an electric light and power company is eligible to enter the competition.

Papers may be of any length and should be typewritten on one side only.

The first page of the manuscript must give the following information:

The title of the Contest, viz., Customer Benefits Contest; name of the author; name and address of employing company; title or character of position; and home address.

Submission of a paper carries with it the privilege of reproduction in whole or in part for inclusion in the Reddy Kilowatt Program or such other use as the judges may authorize.

In judging the papers the Judges will give primary consideration to the answers in terms of Customer Benefits; consideration will also be given to arrangement of answers or statements lending themselves to ready and forceful use with Customers or Prospects; and lastly, to the amplifying or supporting details of specific or collateral advantages.

In submitting an entry the contestant agrees to abide by the decision of the Judges.

All papers must be forwarded before Dec. 10, 1938, in duplicate, to the Customer Benefits Contest Committee, Room 2650, 420 Lexington Avenue, New York, N. Y.

Winners will be announced by February 1, 1939.

The Contest will be judged by the following, whose decision will be final:

C. A. EASTMAN, Ebasco Services, Inc., New York, N. Y.
J. F. GASKILL, Philadelphia Electric Co., Philadelphia, Pa.
A. D. MCLAY, Detroit Edison Co., Detroit, Mich.
W. H. SAMMIS, Commonwealth & Southern Corp., New York, N. Y.
H. C. THUERK, Utility Management Corp., New York, N. Y.

This Contest is sponsored by Reddy Kilowatt, © Ashton B. Collins, Webb Crawford Building, Birmingham, Ala.

McGraw Prize Paper

Staybolt Replacement

By C. D. Reid

A HYDROSTATIC test on our No. 4 box-header type boiler disclosed forty cracked or broken staybolts. The conventional method of replacing staybolts by riveting ends would have been very costly. The purpose of this paper is to explain an unusual type of staybolt used in repairing this boiler which resulted in a saving of more than $10,000.00. There are innumerable installations of box-header type boilers, therefore it seems likely that the method of staybolt repair used on this particular boiler would be applicable to other similar boilers.

Seven of the nine boilers installed at this station are box-header type boilers. These boilers have a maximum steaming capacity of 75,000 to 150,000 pounds of steam per hour at 300 pounds pressure.

A hydrostatic test made on No. 4 boiler, December 22, 1937, revealed that thirty-nine staybolts in rear box-header and one in front box-header were leaking through tell-tale hole in outer end of staybolts. These staybolts are 1½" in diameter and 12" long. Figure No. 1 shows layout of tubes and staybolts in box-headers. The thirty-nine defective staybolts in rear box-header are indicated on this sketch.

To have replaced these staybolts in the conventional way would have necessitated cutting out most of the steamer tubes to use a riveting hammer on inner ends of staybolts. Furthermore if this method of installation had been resorted to it would have been most advisable to remove all the three-hundred-sixteen steamer tubes and replace all eight-hundred-twenty staybolts to prevent a similar occurrence making necessary the removal of more steamer tubes.

Removal and replacement of all steamer tubes and all staybolts would have cost in excess of $12,000.00. Whereas by employing the uniquely designed staybolt described herein it was possible to replace the broken or cracked staybolts without the removal of a single steamer tube, at a cost of approximately $2,000.00. This resulted in a saving of approximately $10,000.00.

MR. REID

Mr. Reid is the winner of the Third James H. McGraw Prize for 1938.

Mr. Reid received his grammar and high school education in Altus, Okla., and graduated from the University of Oklahoma in 1923 with a Bachelor of Science degree in Mechanical Engineering.

He began work for the Oklahoma Gas and Electric Company as Efficiency Engineer in the company's generating station in Muskogee in 1923 and was later transferred to Fort Smith, Ark., and later to the company's generating station at Horseshoe Lake. He was successively Assistant Results Engineer, Results Engineer and in 1937 was promoted to Chief Engineer, which position he now holds.

Nature of Staybolt Failure

Removal of a number of the defective staybolts showed that transverse cracks in staybolts occurred in about the center of handhole sheet. Factory riveting of ends of staybolts swelled approximately the first three threads on outer end of staybolts to a tight fit in sheet. Cracks occurred, in most instances, just back of these first three threads as shown in Figure No. 2. Tests and micrographs of several specimens of the cracked staybolts indicated that failure was not characteristic of caustic embrittlement but was probably due to fatigue and improper installation procedure.

Design and Installation of Staybolts

After much thought had been given the problem it was decided to make a special tapered tap to run through tube sheet from furnace side and tap threads in tube sheet on a taper of ¾" to the foot. Then make a staybolt with a similarly tapered thread at one end. Staybolt to be screwed in through both sheets from furnace side until tapered threads were tight in tube sheet. Outer end of the staybolt to be fitted with washers and nut.

Figure No. 3 shows design of special staybolt which meets the A.S.M.E. code requirements and has the approval of the State Boiler and Insurance Company authorities, as well as representatives of the boiler manufacturer. Center section of staybolt was turned down and threads omitted to simplify construction. A square section was machined at outer end of staybolt for use in tightening staybolt in tube sheet. Figure No. 4 shows a completed staybolt.

All of the forty cracked staybolts were removed by being cut off next to each sheet on inside of box-headers with acetylene torch. Drilled 1¼" holes in remaining plugs and knocked out threaded shells. Threads in sheets were in fair condition but were slightly out of pitch, due probably to stretching of the original staybolts.

Figure No. 5 shows special tapered tap used to tap tube sheet. Guide threads on tap kept threads in the two sheets in pitch. A cradle, constructed of a piece of 2" pipe 2 feet long with a rod brazed to one side of it was used to lift tap up the narrow lane between rows of steamer tubes. Extension on end of tap was started through a stay-

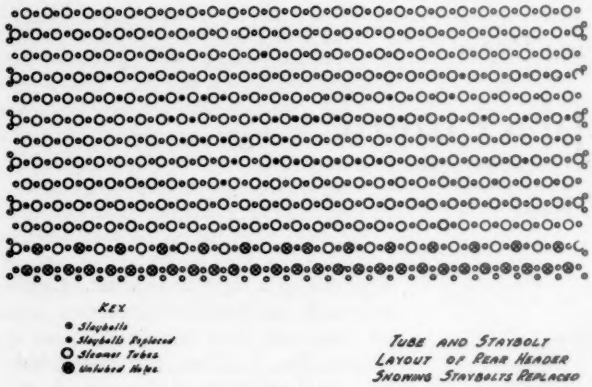


Fig. 1

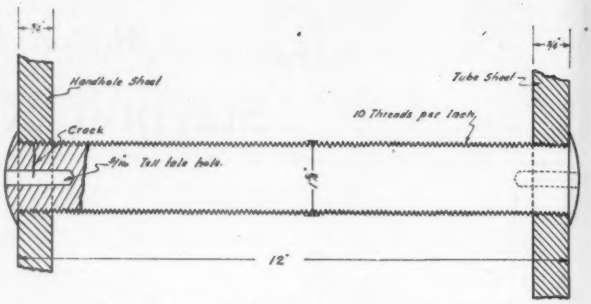


Fig. 2—Sketch of original staybolt showing crack at handhole sheet

bolt hole. Then it was grasped by a person outside of boiler, turned until guide threads were in handhole sheet and tap entered tube sheet.

By trial it was determined how far it was necessary to run tap into tube sheet to give full clean threads. Then all staybolt holes were tapped this amount. A fly cutter was devised which operated through each staybolt hole to give a machined surface on furnace side of tube sheet. This was done to make possible metal to metal contact of staybolt heads with tube sheet. Next the fly cutter was reversed and a machined surface cut around each staybolt hole on outside of handhole sheet to make possible metal to metal contact of handhole sheet and conical washer.

Staybolts were machined from staybolt stock purchased from boiler manufacturer with analysis and strain characteristics in accordance with code requirements. Tapered threads on staybolts were made slightly larger than tapered threads in tube sheet. Final fitting of staybolts was accomplished by tap and try method. When a staybolt was ready to install a mixture of three parts of litharge and one part glycerine by weight was painted freely on tapered threads on staybolts. Staybolt was handed to man in furnace who placed it in cradle, moved it up lane between rows of tubes and started square end through tube sheet. Men outside of boiler started it in threads by hand then with a speed wrench ran it rapidly into place. A heavy socket wrench was then placed on the square end of staybolt and staybolt was tightened by two men with four foot bars, until head of staybolt contacted tube sheet. The threaded conical copper gasket was run on by hand until within ½" of handhole sheet. Then litharge and glycerine was painted on staybolt threads and machined surface of handhole sheet. Copper washer was quickly run down against handhole sheet, conical steel washer was placed against it and a nut made of 2½" hexagon steel was run on and tightened. Fresh litharge and glycerine was mixed for each staybolt.

The conical copper washer shown in Figure No. 6 was machined on a 28 degree angle. A flat section was left at bottom of conical section. The steel washer, also shown in Figure No. 6, was machined on a 30 degree angle and when placed over copper washer could come within 1/16" of flat section of copper washer. When nut was forced against these two washers the first action was to force threads at outer edge of copper washer firmly into staybolt threads. Further pressure forced addi-

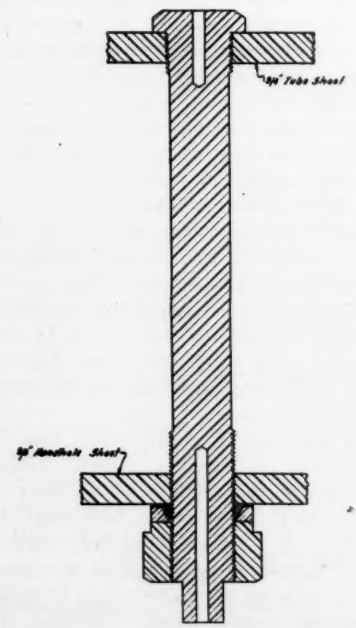


Fig. 3—New type staybolt assembly

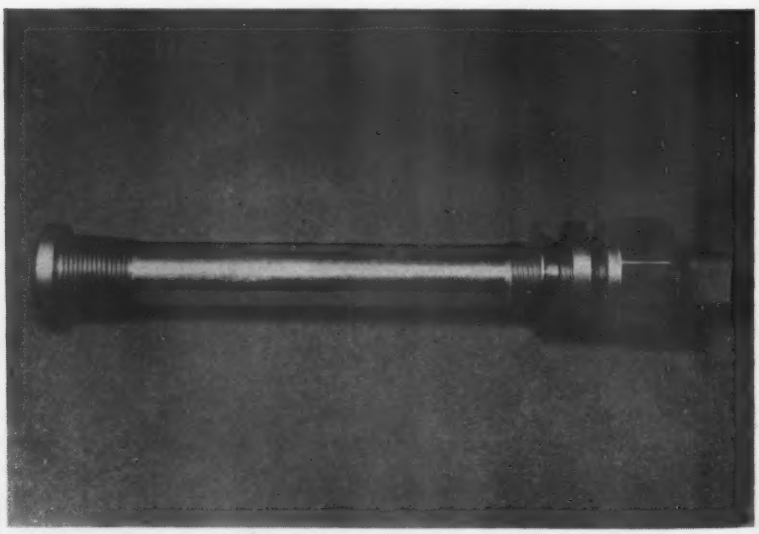


Fig. 4

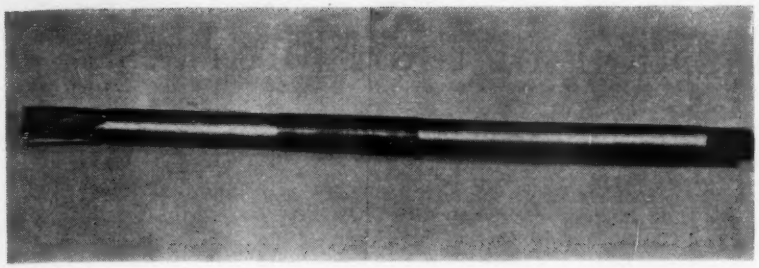


Fig. 5

tional threads of copper washer solidly against staybolt threads, at same time forcing copper washer down against handhole sheet. Continued tightening of nut forced steel washer on down, stretching it slightly, until solid contact was reached against flat section of copper washer. Figure No. 3 shows staybolt as installed.

After the new staybolts were installed as described the boiler was subjected to a 450 pound hydrostatic test, on January 21, 1938, and no leaks were found. The test revealed one additional cracked staybolt in front box-header which was overlooked at time of previous test. This staybolt was replaced with a new type staybolt. Figure No. 7 shows a section of rear box-header after installation of new type staybolts. The left hand threaded tip on staybolts shown in photograph was made to facilitate screwing staybolts into place. It was later found that these tips were unnecessary.

Conclusion

No. 4 boiler has been in operation more than a month since repair and careful inspections have revealed no leaks.

The different steps of designing tap, fly cutter, staybolt, and washers required considerable time and expense. However, now that the design has been perfected and proper tools and material is on hand, the time necessary for renewing staybolts can be reduced materially. If staybolts are made in advance we estimate that two or three old staybolts could be removed and new type staybolts installed in eight hours by four men. About ten man-hours are required to make a staybolt complete with nut and washers.

Fig. 7

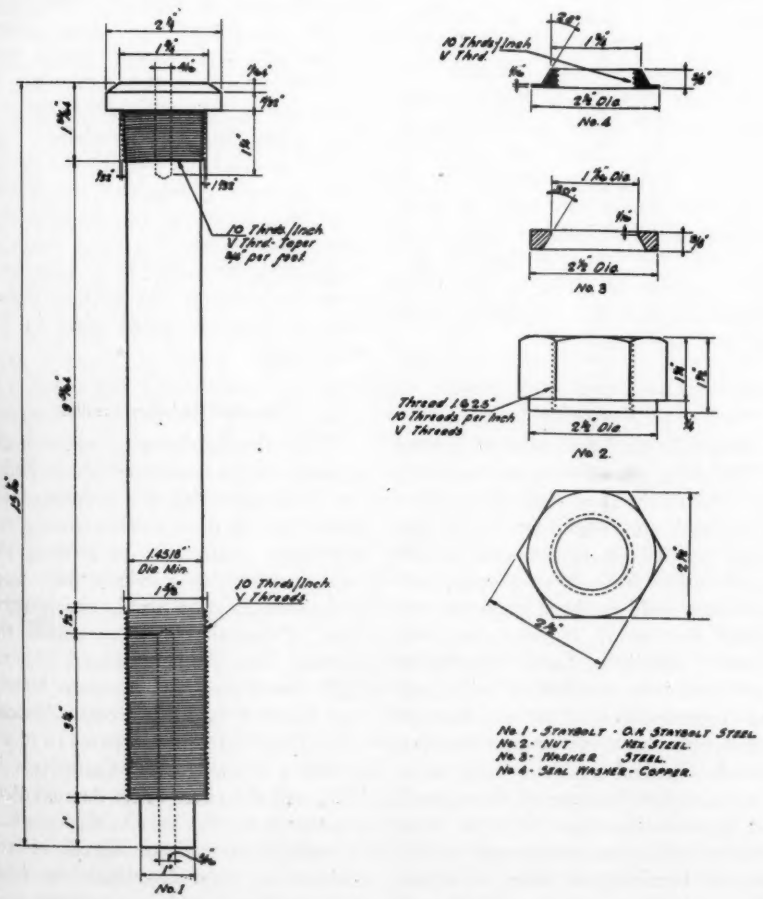

10 Thds/Inch V Thrd- Taper ¾" per foot
10 Thds/Inch V Threads
No. 1
10 Thds/Inch V Thrd
2¾" Dia
No. 4
1 7/16 Dia
2½" Dia
No. 3
Thread 1@28" 10 Threads per Inch V Threads
2¾" Dia
No. 2
No. 1 - Staybolt - O.H Staybolt Steel
No. 2 - Nut - Hex Steel
No. 3 - Washer - Steel
No. 4 - Seal Washer - Copper

Fig. 6—Detail of staybolt parts

Romance of Business

(*Continued from page* 398)

uses one taxpayer's money to destroy another taxpayer's business.

7. Government should not experiment beyond its means to pay and pass the debt on to other generations.

8. Illegal and unscrupulous business should be dealt with by the law, but legitimate business should be freed from the suspicion of abusive propaganda.

9. There is no magic about taxes. Businesses may collect them—but the people pay them.

10. Let us be done with mutual bickering; with millennial reforms; with a financial system resting on the notion that "we can borrow ourselves out of debt." Let us set up the rules of sound business and then let's free industry to build in the spirit of American Pioneering.

Instead of tinkering with the lights on the stage, let's raise the curtain so the "show can go on." Not all the actors in this business world are villains.

There's still romance in American business.

Rural Electrification in the Northwest

By Berkeley Snow

Executive Secretary, Northwest Electric Light and Power Association

Abstracted from a paper presented at the Institute on Northwest Affairs, Conference on Power, Reed College, Portland, Oregon

THE problem of bringing central station electricity to the rural areas in our Northwest states has engaged the attention of many people both within and outside of the electric utility industry for a considerable period of time. This report will undertake to portray the growth and development of rural electrification in this territory, and explain the processes by which electric power has been brought to over 200,000 users outside our cities, 96,000 of which classify as farms, and to reveal some of the economic considerations involved in the construction of the 21,500 miles of rural distribution line from which these users are served.

Pioneering

Contrary to an existing belief, which, because of its falsity, I hope may not gain wide currency, the desirability of electrifying the farms of our country is not a new social-economic concept that has just dawned in the minds of men. I do not know when the idea was conceived but I do know that it was put into practice experimentally in this territory over 30 years ago. In fact, I will make the statement, subject to revision if it can be proven erroneous, that the cradle of farm electrification in the United States is in Oregon, about 70 miles from this spot; that the very first electric distribution line built in the United States to serve electrical energy to dirt farmers was built in the Hood River Valley, Oregon, by a predecessor of Pacific Power & Light Company. This happened in 1906, 32 years ago almost to a day. This line ran along Brookside Drive about one mile from the edge of the town of Hood River for a distance of two miles, and when it was completed it served five farm customers. Last year Pacific Power & Light Company connected its lines in Oregon and Washington to its 10,000th farm customer, and today one-fifth of all that company's residential customers are farms.

Pacific Power & Light Company is not the only pioneer in rural electrification in this territory. Puget Sound Power & Light Company, serving a large area of the state of Washington, chiefly west of the Cascade Mountains, dates the beginning of farm electrification in its territory from 1909. Idaho Power Company, whose territory extends generally east and west across the southern part of Idaho in the Snake River Valley, began to build farm lines about 1910. Mountain States Power Company, serving a section of the Willamette Valley south of Salem, Ore., started in 1911, and Portland General Electric Company went seriously into the business of extending lines into rural areas around Portland in 1914. Many other companies have contributed to the rural electrification existing in the Northwest today, and some of these may also date their pioneer efforts back about this far. Thus it may be said that a quarter of a century ago rural electrification in our Northwest states was well under way.

Economics

Obviously the investment of around $25,000,000, representing the approximate cost of the rural lines in our three states, and the establishment of this highly specialized department of the electric utility business on a going concern basis, could not have happened over night. Nor could it have happened without intelligent and cooperative study by a large number of individuals and organizations. Let us examine some of the economic factors entering into this general problem, and, while so doing, note who some of these people and organizations are. At the same time we will come across some of the economic barriers that hinder us in our progress along the road toward the goal of 100 per cent electrification of rural areas.

Business Philosophy

First and foremost in the substantial progress that has been made have been the private utility companies themselves. They experimented on their own initiative long before any demand had developed. Recognizing that the fundamental economy of the region was agrarian in character, they set about studying how farming and businesses allied with farming could be made customers for utility services. This led to the development of a business philosophy that says, in effect, the well being of the city depends to a large extent on the farm, and whatever can be done to build up the farmer's standard of living and income will benefit the city dweller and the state as a whole. This concept brought about the adoption quite generally throughout the Northwest of a theory of rate making that now provides rates for rural users of electricity uniform over large areas, and, generally speaking, but slightly higher than the rates to urban users in the same areas.

Electrical Industry Studies

With that philosophy as a background, the companies set about building rural extensions, and promoting intensive use of their services among the new farm customers. In meeting the early problems with which they were confronted in this work, much good came of committee studies within the industry through the National Electric Light Association and our own Northwest Electric Light & Power Association. Our Northwest Association formed a Rural Service Committee in 1921, and the pages of its Annual Proceedings from that year to this are full of reports on various aspects of the problem of rural electrification, from the engineering problem of building safe,

dependable and low cost lines to the sales promotion problem of building up the farm loan, and consequent revenue to the company. Here, of course, is the meat in the cocoanut. Extensive rural electrification is possible only under conditions in which the investment cost in lines and the revenue from this investment can be kept in economic balance. The object of these studies from the beginning has been to bring line costs down and revenues up, and much headway has been made in both directions—and this has been a major factor in the growth of rural electrification in this territory.

Research

But line costs could be controlled only within comparatively narrow limits, whereas the possibilities of building up the farmer's use of electricity seemed to offer opportunity for greater results. The need of a research organization was seen and steps were taken in 1923, through the cooperation of several interested organizations, such as the American Farm Bureau Federation, the American Society of Agricultural Engineers, associations of farm equipment and light plant manufacturers, U. S. Department of Agriculture, and the National Electric Light Association, to form the National Committee on Relation of Electricity to Agriculture. State committees were organized soon thereafter: Oregon in 1924, Washington and Idaho in 1925. These committees, consisting of representatives of the agricultural colleges in each state, leading farmers, equipment manufacturers and utility people, were set up as research organizations to find and prove economic uses of electricity in agriculture, and their success in this field has been notable. Tribute is due to the directors of this work, because of the marked influence they have exerted toward extending and stabilizing rural electrification in these three states.

Promotion

The promotion of the uses proven by these committees is, of course, largely a commercial matter, and this has been undertaken aggressively by the utility companies and equipment manufacturers. It was shortly found that this was a highly specialized business, and new departments for handling it were created in all the major utility companies serving our Northwest states. Men with agricultural experience or training were sought for these departments so that their approach to the problem would be from the farmer's viewpoint. The chief function of these men has been to show the farmer ways in which he could utilize electricity to cut costs or increase the quality or quantity of his crops, and thus in one way or the other produce additional net income to the farm. Thus the promotion has been on a sound economic basis, and today we recognize these specialists in rural electrification as being a large contributing factor to the progress that has been made.

Line Extension Rules

Another important element in the situation has been the constructive attitude of the regulatory commissions of the three states. In the first decade of the development, 1910 to 1920, utility companies, through their studies of the cost of lines and the revenues derived from them, set up definite bases on which they would make extensions uniformly throughout their territories, so as not to discriminate between groups of prospective customers. The state commission soon recognized the desirability of uniformity throughout their jurisdictions, and early in the 1920's they devised rules and regulations to apply in their respective states. These extension rules have undergone modification from time to time in the light of experience, always in favor of the farmer. They are based on the principle of establishing an economic ratio between investment and revenue for all proposed extensions, and, if the revenue on a given extension is estimated to be insufficient to meet these established conditions, the deficiency is prepaid in a lump sum or guaranteed monthly for a period of years by the prospective customers. After the line is built and again after it has been in service for a period of time, adjustments are made if they are due the customers. The technicalities involved preclude a more detailed discussion at this time, but the point I want to emphasize is that the existence of definite and uniform rules covering this important phase of rural electrification, protecting the utility and the farmer alike, has had a stabilizing influence tending to encourage the building of rural lines and the contracting of electrical business thereon, and thus has been a factor making for progress.

Natural Factors

Many other factors, some favorable and some unfavorable, bear on the general situation. I refer now to natural factors, such as climate and soil that determine the type of farming that can be carried on successfully in different areas. Remember that the cost of lines remains fairly constant, but that the volume of electrical business that can be secured on these lines varies widely with the type of farming in the area, tending, therefore, to increase or limit the possibilities for rural electrification of that area.

Where land is capable of intensive cultivation and farms are small, there are more customers per mile of line, meaning more revenue per unit of investment. On the other hand, in those areas where the farms are larger, and hence fewer to the mile, the use factor is a determining element. Where irrigation water must be pumped, as in sections of eastern Washington and Oregon and southern Idaho, the way has been opened for the promotion of pumping by electricity, and the additional revenue from this source has helped to electrify the whole rural area. Fruit farming, poultry raising and dairying are types of farming that can make liberal economic use of electric services, and the areas in which these predominate are quite generally electrified. Dry wheat farming and stock farming areas with large and hence fewer farms, are the areas presenting the most baffling problem at the present time—a problem further complicated by the fact that few economic uses of electricity for these types of farming have yet been found.

Strangely enough the availability of cheap fuel is a factor, since in areas where it exists, frequently in the form of wood on the farm that may be cut during the winter when the farmer is not otherwise very busy, the farm home is not a very good prospect for an electric range. On the other hand, in areas where coal and wood are expensive, the electric range becomes desirable for economy as well as for its other advantages, and, being a good revenue builder, aids in producing the revenue that goes to make the building of rural lines possible.

Financing the Farmer

One other factor needs brief mention

TABLE I—NUMBER AND PERCENTAGE OF FARMS USING CENTRAL STATION ELECTRIC SERVICE IN IDAHO, OREGON AND WASHINGTON

	Idaho, Oregon and Washington		Idaho		Oregon		Washington		National
	Number of Farms Served	Percent of Total Farms	Number of Farms Served	Percent of Total Farms	Number of Farms Served	Percent of Total Farms	Number of Farms Served	Percent of Total Farms	Percent of Total Farms
1923	23,711	14.2	5,000	12	5,240	9.5	13,471	19	2.8
1924	25,346	15.1	5,209	12.5	5,957	10.8	14,180	20	....
1925	28,792	17.2	5,834	14	7,005	12.7	15,953	22.5	3.9
1926	34,017	20.3	6,876	16.5	7,997	14.5	19,144	27	....
1927	41,307	24.7	8,335	20	9,928	18	23,044	32.5	....
1928	51,756	31.0	10,419	25	12,685	23	28,652	39	....
1929	54,797	32.8	10,835	26	14,891	27	29,071	41	....
1930	61,483	36.8	12,085	29	15,719	28.5	33,679	47.5	10.4
1931	64,933	38.9	12,402	29.8	16,388	29.7	36,143	51	11.1
1932	67,033	40.1	12,718	30.5	16,554	30	37,761	53.3	11.25
1933	68,412	40.8	12,768	30.7	17,156	31.1	38,488	54.2	11.35
1934	71,332	42.6	13,433	32.3	17,839	32.3	40,060	56.4	11.85
1935	74,610	40.5	14,872	35.5	19,284	31.6	40,454	49.8	12.25
1936	77,869	42.2	16,362	39	20,337	33.2	41,170	50.7	13.95
1937	96,170	52.2	20,109	48	29,016	47.5	47,045	58	19.3
Total Farms 1935	184,161	....	41,919	....	61,137	....	81,105	....	6,422,088
Total Farms with Dwellings valued over $500—1935	145,671	....	30,779	....	49,134	....	65,758	....	4,328,092
Relation of electrified farms to total farms having dwellings valued over $500.00	.....	66.4	.....	65.3	.....	59.1	.....	71.5	28.7

*Farms Served Nationally, Dec. 31, 1937—1,241,505.

TABLE II—RURAL CUSTOMERS (FARM PLUS OTHER RURAL) AND MILES OF RURAL DISTRIBUTION LINE, OF MAJOR COMPANIES AND MUNICIPALS SERVING IDAHO, OREGON AND WASHINGTON

	TOTAL		IDAHO		OREGON		WASHINGTON	
	Rural Customers	Miles of Line	Rural Customers	Miles of Line	Rural Customers	Miles of Line	Rural Customers	Miles of Line
Calif. Ore. Pr. Co.	6,017	1,024	.....	.....	6,017-S	1,024	.....	.....
East. Ore. Lt. & Pr. Co.	785	163	.....	.....	785	163	.....	.....
Grays Harbor Ry. & Lt. Co.	983	57	.....	.....	.....	.....	983	57
Hermiston Lt. & Pr. Co.	109	27	.....	.....	109	27-A	.....	.....
Idaho Power Co.	18,162	3,076	16,712-E	2,698	1,450-E	378	.....	.....
Mountain States Pr. Co.	11,018	1,170	131	28	10,873	1,139	14	3
Northwestern Elec. Co.	5,800	743	.....	.....	548-E	117	5,252	626
Pacific Pr. & Lt. Co.	14,522	1,771	.....	.....	3,873-E	529	10,649	1,242
Portland G. E. Co.	36,320	2,876	.....	.....	35,866	2,851	454	25
Puget Sound Pr. & Lt. Co.	83,177	6,000	.....	.....	.....	.....	83,177	6,000-E1
Utah Pr. & Lt. Co.	7,183	1,023	7,183-E	1,023	.....	.....	.....	.....
Washington Gas & Elec. Co.	578	37	.....	.....	.....	.....	578	37
Washington Water Pr. Co.	11,117	{ 635-C 1,495	3,112	{ 200-C 332	.....	.....	8,005	{ 435-C 1,163
West Coast Pr. Co.	4,746	603	467	84	2,074	277	2,205	242
Total Private Companies	200,517	20,700	27,605	4,365	61,595	6,505	111,317	9,830
Eugene Water Board	1,814	105	.....	.....	1,814-R	105	.....	.....
Seattle-City Light	3,435	111	.....	.....	.....	.....	3,435	111
Tacoma—Light Dept.	1,831	97	.....	.....	.....	.....	1,831-N	97-N
U. S. B. R.—Minidoka Project	1,344	300	1,344	300	.....	.....	.....	.....
R. E. A. Projects (Table III)	613	172	574	159	.....	.....	39	13
Total Munic.-Govt.-Coops.	9,037	785	1,918	459	1,814	105	5,305	221
Grand Total	209,554	21,485	29,523	4,824	63,409	6,610	116,622	10,051

All above figures as of dates between Nov. 1937 and June 1938.

A—Approximate.
E—Estimated—(1) by compiler.
C—Customer—owned Lines Served by Co.
R—Residential Customers Only.
S—Suburban Customers not included.
N—Not including lines and customers of 11 small mutual companies buying wholesale from Tacoma.

to get the broad economic problem of rural electrification before you. This is the ability, or lack of it, of the farmer to finance his own investment in wiring and devices through which to use electric service. In many cases this is a more important consideration than the rate for electrical energy in determining whether or not a farmer can and will become a customer on a proposed line extension. The relation of the customer's use to his investment in equipment through which he enjoys this use has been a subject of study by the utility people for some time and many easy term plans have been devised, frequently in cooperation with banks and finance companies. More recently the problem has had the attention of government financing agencies, such as the Electric Home and Farm Authority and the Rural Electrification Administration, and unquestionably the aid of these agencies will be a favorable factor. But let it be understood here that this matter of financing the investment the farmer must make to electrify his farm does come prominently into the picture in any consideration of the economics involved in rural electrification.

Distinction—"Rural" and "Farm"

So much for the economics of the situation. Let us now look at the result of all this—the extent to which the rural areas in those three states are electrified. When we refer to "rural" customers we refer to all users of electricity located outside of cities, whereas "farm" customers are those making a business of farming—those conforming to the U. S. Bureau of Census definition of a farm. Under this definition some few farms are inside the corporate limits of cities, but not enough to distort our rural statistics materially.

Rural customers then, as considered in this report for statistical purposes, are all those of whatever character outside the corporate limits of incorporated communities. Included, besides farms, are suburbanites who crowd the environs of the larger cities almost as densely as the residential districts within the city itself. Then there are small unincorporated communities with their stores and business establishments, their churches and schools. Then along main highways are the roadside eating places, filling stations and small stores. In some farming districts are found a few electrical users more like the industrial plants of cities in the kind of use they make of electric service, such as fruit packing houses, nut and hop drying houses, cold storage plants, canning factories and cheese factories. All these classify as rural when they lie outside of incorporated cities, and, frequently the electric revenues they have supplied have made possible the construction of rural lines that have brought electric power to many farm homes. Now with this distinction between "rural" and "farm" customers in mind let us look at the growth in farm electrification in our three states over the past 15 years. (Table I.)

Farms Electrified

An important point to note here is the number of farms in the three states having dwellings valued at less than $500: about 11,000 in Idaho; 12,000 in Oregon; and 15,300 in Washington. Obviously these cannot be very good prospects for electric service. If we remove them from consideration, we see that two-thirds of the better farm prospects are now being served.

As a matter of interest, Washington is seventh among all the states in percentage of farms served; Idaho is tenth and Oregon eleventh. Rhode Island is first, and California second. Other high ranking states are Arizona, Connecticut, Massachusetts, New Hampshire, New Jersey and New York—all with more than half their farms receiving central station service.

Rural Customers and Lines

Let us now look at a compilation of individual records in rural electrification in the Northwest as to numbers of customers and miles of line. (Table II.) Here I have listed the major private and municipal utilities, government and R. E. A. projects serving any portion of the three states, giving the number of their rural customers and the miles of line from which those customers are served. These figures are all of fairly recent date, though not all of the same date; but for all practical purposes, they portray the situation as we find it today. They are, however, not complete, omitting, as they do, a number of small companies and municipals in all three states. My guess is that they represent better than 97 per cent of the total rural electrification of the territory. Municipal utilities have never figured very prominently in rural or farm electrification, primarily, I believe, because of charter limitations. Few of them now extend their lines very far beyond the suburban areas just outside their city limits.

R.E.A.

I have been asked to discuss the place in the general picture taken by the Rural Electrification Administration. This, as you know, is the government agency set up in 1935 to provide funds to loan to farmers' cooperatives and private companies for the purpose of extending rural electric lines. It also loans money to build generating plants where the area to be served is isolated from existing lines, and, recently, it has provided funds in some cases to loan to individual farmers for electric wiring on their premises. Table III, compiled from official reports, lists in the first three columns all the projects for which allotments have been made by the R. E. A. in these three states as to amount allotted, number of miles to be built and number of customers to be served. In the second three columns is shown the status of these projects as of May 10, 1938, the last available monthly report. The summary consolidates the figures into projects completed, under construction and not yet started. You will note that approximately one-half the projected work is under way, and I can add that parts of at least four of the projects listed as under construction have been energized in the past few weeks.

From these figures it is seen that the contribution of the R. E. A. to rural electrification in this territory to date has not been of any considerable proportions, but this statement is not meant to contain a derogatory inference. R. E. A. has been in existence only about three years and here it is operating in a territory pretty well covered, where projects meeting conditions required to liquidate the loans are not numerous.

Future

That is my story of the situation as we find it today. What of the future?

Have we reached the point of saturation—the economic limit? My answer is no, but if I thought conditions and human ingenuity would remain stationary from today on I would add that we might reach saturation in a few years. As a matter of fact, we know that conditions are constantly changing and nothing is so mobile as human ingenuity and enterprise. Therefore we may expect to continue to approach 100 per cent electrification of rural areas from central station lines—though I do not say we will ever reach that figure in its absolute mathematical sense.

Remember this—that bringing central station electric service to rural customers depends on the relation between two things—(1) cost of distribution lines and (2) revenues that can be secured from those lines through use of the service. Anything that tends to bring those two things closer together will make possible the extension of lines into areas not now served—the sparsely settled fringes of well-settled territory—and many things can happen which I will not take time to enumerate.

For the hermit in the mountains, or the great grain and stock baron of the plains dwelling in splendid isolation in the midst of his vast holdings, there is always the individual fuel-driven light plant.

From the immediate present, we who have this business at heart, whose job it is to make it progress (and I mean to include all those referred to in this report), will continue to work, and for the next several years at least, I feel confident that the curves I showed you will continue to rise, and the benefits of this service will continue to be spread to more and more farms and rural dwellers in the Northwest.

Table III—R.E.A. Projects in Idaho, Oregon, Washington For Which Funds Have Been Allotted as of May 10, 1938

	Allotments			Status as of May 10, 1938 Under Construction or Completed			
	Allotment	Miles	Customers	Cost or Contract	Miles	Customers	
IDAHO							
Nor. Idaho Rural Elec. Rehab. Assn... Bonner	$208,750.00	178.5	765	$159,484.64	159	574	Energized, 1937 Report, as of Nov. 15, 1937.
Clearwater Val. Lt. & Pr. Assn..... Nez Perce	762,000.00	709	2,229	208,092.06	232.5	512	Under Construction, 1937 Report, as of Nov. 15, 1937.
Total *Idaho*.....	970,750.00	887.5	2,994	368,576.70	391.5	1,086	
OREGON:							
Blachly-Lane Co. Coop. Elec. Assn.... Lane	117,000.00(1)	87	420	53,999.70	49	307	Under Construction, 1937 Report, as of Nov. 15, 1937. Constr. of Gen. Plant started 3/38 Rpt. as of 2/10/38.
Nehalem Val. Coop. Elec. Assn..... Clatsop	65,000.00	54	276	69,898.76	50.5	276	Under Construction, 1937 Report, as of 11/15/37.
Umatilla Elec. Coop. Assn..... Umatilla	179,000.00(2)	153	643	129,000.00	120	577	Construction started, Feb. 1938, Report as of 1/10/38.
Total *Oregon* (5).....	361,000.00	294	1,339	252,898.46	219.5	1,160	
WASHINGTON:							
Benton Rural Elec. Assn..... Benton	49,000.00(3)	43	150	45,000.00	43	150	Construction started 2/1938 Report, as of 1/10/38.
Orcas Pr. & Lt. Co..... San Juan	87,000.00	70	200	87,000.00	70	200	Construction started 2/1938 Report, as of 1/10/38.
Mut. Pr. & Lt. Assn. of Tanner..... King	19,200.00	13	38	19,161.53	13	39	Energized, 1937 Report, as of Nov. 15, 1937.
Inland Emp. Rural Electr. Inc..... Spokane	699,000.00	681	1,980	270,553.56	283.5	510	Under Construction, 1937 Report, as of Nov. 15, 1937.
Quinault Light Co..... Grays Harbor	79,000.00(4)	23	150	41,000.00	....	....	Constr. of Gen. Plant started 5/38 Rpt. as of 4/10/38.
Pub. Util. Dist. No. 1 of Cowlitz Co.. Cowlitz	88,000.00	81	305	88,000.00	81	305	Construction started, 3/38 Report as of 2/10/38.
Pub. Util. Dist. No. 1 of Lewis Co.... Lewis	71,000.00	66	216	.....	....	....	
Total *Washington*.....	1,092,200.00	997	3,039	550,715.09	490.5	1,204	
Total 3 States.....	2,423,950.00(6)	2,158.5	7,372	1,172,190.25	1,101.5	3,450	
Per Cent of Total Allotments to Date.	.....	.....	.....	48.3%	52.3%	46.8%	

(1) Includes $19,000 for Generating Plant.
(2) Includes 15,000 for Wiring.
(3) Includes 4,000 for Wiring.
(4) Includes 41,000 for Generating Plant.
(5) Exclusive of $100,000 allotted to Portland Gen. Elec. Co. for 109 Miles of Line to Serve 572 Customers. Allotment held up.
(6) Equals 2.77% of $87,624,814 Total Allotments to May 10, 1938. The 3 States have 3.37% of all the farms in U. S. having dwellings valued over $500.

Summary—May 10, 1938

	Number	Miles	Customers
Projects Completed in whole or in part.....	2	172	613
Projects Under Construction in whole or in part....	9	929.5	2,837
Parts of above Projects not started.....	(6)	991	3,707
Projects not started.....	1	66	216
Total Allotments to Date.....	12	2,158.5	7,373

Lighting of Philadelphia Electric Company Properties

By Walter B. Morton

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GOOD lighting is no longer regarded as an extravagance but is being universally recognized as a necessity to health and personal efficiency in homes, stores, offices and factories. The Better Lighting campaigns of recent years have given a new impetus to this modern trend to better illumination. Adequate lighting of Central Station properties is also receiving greater attention and is now considered an important engineering problem in the design of new stations. This interest is necessary not only to maintain the health of personnel and improve their operating efficiency, but also to set an example for customers whose lighting is inadequate and in need of modernization.

The Philadelphia Electric Company has conducted a program of gradual replacement of inadequate lighting facilities in the older stations and in this connection the Engineering Department, in conjunction with the Lighting Service Division, has made a number of investigations to determine the adequacy of existing lighting equipment and what measures should be taken to insure that the lighting in future installations will receive the same degree of engineering attention that is accorded to the remainder of the station. The classes of lighting problems encountered may be grouped as follows:

A. Stations

Control rooms	Oil rooms
Turbine rooms	
Boiler rooms	Plant offices
Emergency lighting	Outdoor substations
Switchhouse aisles and compartments	Protective lighting

B. Other Properties

Showrooms	Drafting rooms
Offices	Workshops

C. Advertising Lighting

Signs	Building flood-lighting

Control Rooms

In designing control room lighting, the main objective is to provide adequate intensity without glare. Three major problems are encountered in this type of lighting project; first, direct glare from light sources within the operator's field of vision; second, reflected glare or high lights on the instrument faces which obscure the scales; and third, the chief cause of eyestrain complaint, the sharp contrast between dark surfaces such as conventional black switchboards, window shades, dados, etc., and the light walls and ceilings.

The chief source of glare is the direct or semi-indirect lighting unit in low-ceilinged control rooms. In many cases glare has been materially reduced by lowering the direct units located behind the switchboard and relocating or shielding those directly above the boards to remove them from the operator's line of vision. In some stations the older fixtures have been replaced with totally indirect units, using lamps of higher wattage. Although in a few cases semi-indirect units were converted to indirect units by the addition of a suitable reflection plate in the bottom of the fixture—thus removing an annoying source of glare, the totally indirect unit of modern design seems to be the best solution to this problem for rooms with low ceilings. The indirect units may be of the improved inverted bowl type or may consist of a series of tubes or small reflecting units located behind switchboards or similar equipment where they

Outdoor substation lighting at Conowingo Hydro Plant

are favorably located to obtain satisfactory distribution.

Any bright source of light, whether from direct lighting fixtures or from undiffused reflected light, will cause reflected glare or highlights in the glass instrument fronts. In aggravated cases this highlight can completely obscure the scales. Here again the best solution appears to be the totally indirect unit for low-ceilinged rooms. Some success has been obtained with elimination of highlights by use of specially constructed "non-glare" glass for instrument cases. The relatively new device "polaroid" may or may not have promise for development in eliminating highlights and is being investigated with both lighting fixture and instrument manufacturers.

The contrast between dark surfaces, such as switchboards, and the light walls and ceilings is most noticeable in control rooms with curved switchboards that "wall in" the operator's desk. Increasing general lighting intensities, in an effort to improve visibility under these conditions, sometimes only accentuates the contrast, aggravating rather than improving the condition.

In an effort to determine what effect on visibility light switchboard finishes might have, experiments were made at several Philadelphia Electric Company substations. To simulate an arrangement of equipment mounted on a light-colored surface, the panels in one-half of a curved switchboard in each station were covered with light-colored paper, with the instruments and devices protruding through holes. The panels in the other half of the board were allowed to remain with the natural black finish. Observers of each exhibit were of the opinion that the visibility on the lighter sections of the switchboard appeared to be superior to that of the black.

Tests conducted from time to time by illumination engineers have shown that visibility of black objects (such as lettering) against a white background is materially better than that of white objects against a black background. Switchboard designers have recognized this point in recommending white-dial instruments in preference to black. In the comparison of switchboard finishes, however, it must be remembered that the observer standing before a switchboard is endeavoring to discern the black letters against the white instrument dials and not the white scales against a black or other switchboard surface. The large expanse of dark background in the black switchboard hampers adjustment of the eyes to the lettering on the scales.

The majority of Philadelphia Electric Company switchboards are constructed of black slate, the surface of which when oiled presents a black velvety sheen. The results obtained from the paper-covering experiments indicated that this black finish was in a measure contributing to the unsatisfactory lighting conditions in certain stations. Obviously, extensive repainting of existing fully equipped switchboards would not be economically feasible. An appreciable improvement was obtained by cleaning off the original oil film with an ammonia solution, leaving the natural dark gray finish. This not only increased the visibility materially but also helped the general illumination conditions. The slate switchboards in all major substations of the system have been treated in this manner.

The first new switchboard to be installed following the experiments in switchboard finishes was required in Flat Rock Hydro Station for remote control of the non-attended Manayunk Substation. This appeared to be an excellent location to give the light-colored switchboard a trial, since the new board was to be adjacent to and in line with a conventional black slate switchboard. The new board is of the miniature-control type using telephone keys for control switches. The use of miniature devices and the concentration of the control of an entire substation on two panels made it especially desirable to use a finish that would provide maximum visibility on the switchboard face.

The color selected for this board was a light buff or tan color with a flat finish to minimize glare. The light color brings out the outline of the small devices in bold relief, whereas similar miniature switchboards in other stations, according to the operators, require more effort to distinguish the small devices against the black background. Operating experience with the light-colored board at Flat Rock has demonstrated the effectiveness of the light finish in improving visibility. Observers agreed that an intensity of less than two foot-candles on the tan-colored switchboard produced better general visibility than that of five to six foot-candles on the adjoining black board. Instrument dials appear to be more easily discerned against the light board. In addition the light finish is much easier to look at steadily, and tends to reduce eyestrain. Consideration is being given to the possibility of repainting other miniature switchboards a light color.

In the design of switchboards for the new 165,000 kw. generator at Richmond Station advantage was taken of the opportunity to obtain additional experience with light-colored switchboard surfaces. In order to obtain a representative and unbiased opinion on the efficacy of a light-colored finish for the new control boards for two 600,000-pound boilers and auxiliaries, two scale models were constructed of wood to represent one of the main boiler-control boards. One model was finished in the conventional black and the other in a light gray. The gray was used in preference to buff in order to match the color scheme proposed for the new addition to the boiler room. The two models, each representing in detail the finished switchboard, were exhibited side by side and inspected by representatives of various interested groups. The agreement was almost unanimous that visibility of the light-gray finish appeared to be materially superior to the conventional black.

The Richmond boiler-control panels represented in the models were painted a silver gray color, similar to aluminum.

The aluminum finish is obtained by first Parkerizing the stretcher-level steel and applying a priming coat of overnight primer followed by two coats of opalescent gray lacquer. This finish coat dries quickly, leaving a surface which is a soft pleasing aluminum finish, easily cleaned with a damp cloth. The absence of gloss in this finish prevents excessive light reflection, at the same time eliminating the undesirable contrast between switchboards and surrounding walls. Radio manufacturers have used this lacquered finish extensively with satisfactory results on radio-control panels.

Operating experience during a three-year period with this finish at Richmond Station has demonstrated its advantages over other types of finish. All new switchboards required in connection with the 50,000 kw. superposed generator installation at Schuylkill Station, except live front switchboard for supplying 240 volt auxiliaries, are being furnished with this aluminum finish.

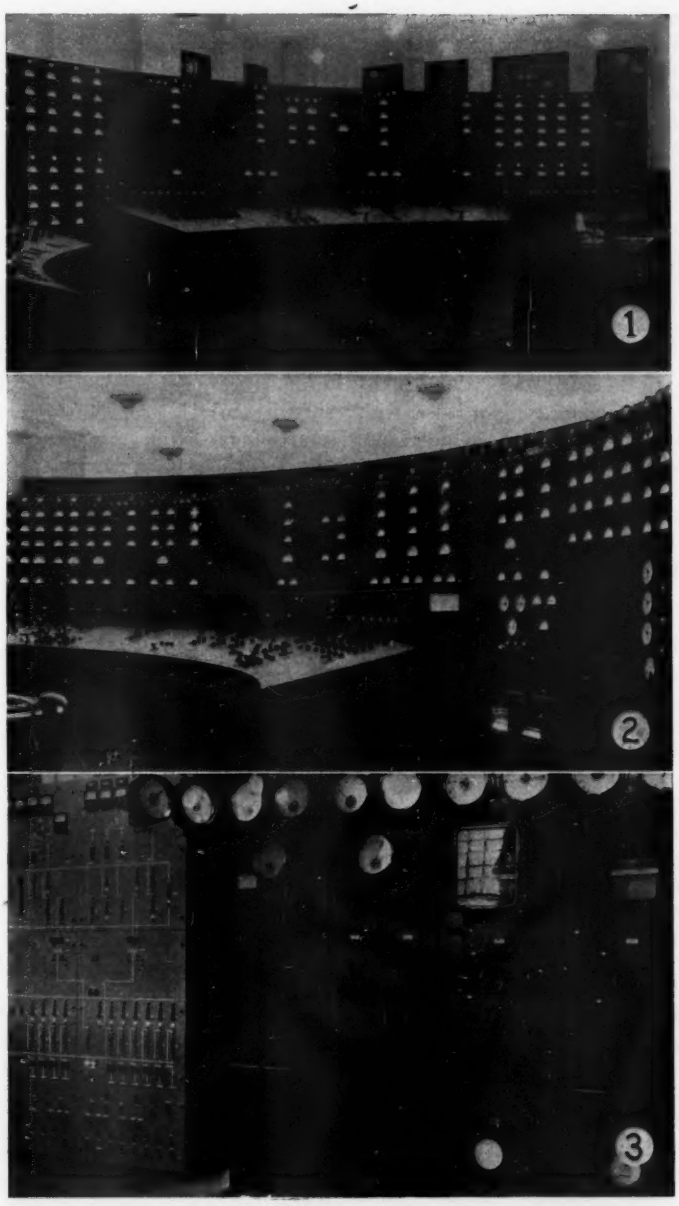
In addition to the tangible advantages of light finish for switchboards, the lighter colors, psychologists agree, tend toward greater efficiency of the operating personnel. Experiments by universities and industrialists have proved that light-

er colors stimulate and promote efficiency, whereas darker colors tend to depress and reduce efficiency. This has been one of the leading arguments in the many lighting campaigns conducted by the industry. The truth of the assertion has only recently been recognized in connection with control-room lighting, but it undoubtedly will be given greater consideration by the designing engineers of future power-station developments.

Since paint, with subsequent maintenance of painted surfaces, is admittedly an undesirable feature in switchboard design, consideration has been given to the use of some form of compound or metal in natural color which does not require painting. Most compound materials with a natural finish, particularly bakelite, have an undesirable reflection created in the polishing of the surface. The polish can be removed by roughing the surface with steel wool but, to a certain extent, this detracts from the appearance of the finish. Stainless steel, brushed to a satin finish, appeared to have promise, although relatively few installations of this material have been made, and its properties as a switchboard material have not until recently become generally known.

A two-panel switchboard required for the control of fuel preparation equipment at Richmond was selected for a trial installation of the stainless steel material. It was felt that, although the first cost of stainless steel is greater than stretcher level steel, the elimination of the painting problem might make the costs somewhat comparable and reduce maintenance expense. However, three years of operation with the stainless steel finish has not brought out any outstanding advantage over the aluminum lacquered finish, and has indicated a decided disadvantage in higher first cost and the difficulty of eliminating glare in the stainless steel finish, even when rubbed with fine steel wool. Also some discoloration occurs with age, which requires periodic resurfacing with the wool.

The best results will be obtained in the design of a new control-room lighting installation by use of totally indirect



1. Direct type units in the high ceiling control room of Westmoreland
2. Totally indirect units at Plymouth Meeting
3. Tan colored board adjacent to conventional black board in Flat Rock Hydro Plant

4. Installation of mercury vapor lighting units at Flat Rock Hydro Plant. Control boards are located in the turbine room

units, and by reducing the area of dark surfaces to a minimum, such as using light colored switchboards and dropping the dado as low as practicable, to 30 inches if possible and not greater than four feet in any case. The indirect units may be porcelain or metal bowls suspended from the ceilings, tubular units concealed behind moldings, or a greater number of individual units of lower wattage located behind vertical switchboard panels, where the switchboards are favorably located to obtain distribution of light by this method.

Ceilings in control rooms should be painted either white or light ivory, with walls just a shade darker. In either case the finish should be eggshell. The reflection factor of this finish is high, at least 80 per cent, and its soft velvety surface produces a minimum of glare. Light intensities should not be less than 10 to 12 foot-candles, preferably 18 or 20.

One annoying problem in connection with control room lighting is the glare from windows, especially on dark days, and near sunrise or sunset. Consideration should be given in the new installation to complete omission of all windows. This removes a serious glare problem and leaves the space normally occupied by windows free for accommodation of conduits and other equipment. It is sometimes necessary, where window glare reduces visibility of control boards, to install some form of concealed floodlights to illuminate the board and offset the glare. An installation of this type has been made in Lamokin Substation.

Visibility of switchboards regardless of finish, is materially improved by the use of flush-type devices. Elimination of a variety of observation levels not only improves the appearance of the switchboard, but assists the lighting engineer in obtaining an even intensity over the switchboard surface.

Although the high-pressure, high-intensity type of mercury-vapor lamp appears to offer considerable promise for application to station lighting, it has not been used extensively, chiefly because of certain inherent disadvantages. The principal disadvantage is the delay of several minutes in coming to brilliancy, and the even greater time required for restarting following a loss of voltage on the unit. Another objectionable feature is the lack of red in the mercury-vajor color spectrum, which results in a color distortion, causing red shades and colors to appear brown or purple. Both of these objectionable features can be reduced to negligible quantities by installing fixtures equipped for both mercury and incandescent units. The incandescent lamps provide the necessary red rays, which when blended with the light from the mercury-vapor units result in a soft diffused white light, simulating natural daylight. A decided stroboscopic effect is noticeable with an excessive proportion of mercury in the combination which under certain conditions may cause distortion of the synchronoscope indication while synchronizing. The low pressure mercury tube is available for use with conventional fixtures and does not have the troublesome stroboscopic effect or long starting period although being somewhat higher in cost and much lower in efficiency than the high pressure tube.

The mercury unit has an efficiency nearly double that of the conventional incandescent lamp, and the quality of light produced is pleasing and restful to the eyes—an important factor in maintaining the highest efficiency in operating personnel. For this reason wider application of mercury-vapor lamps in future station designs may be expected.

Experiments with mercury units are being conducted in the control rooms of several generating stations and results of preliminary tests indicate that some combination of mercury and incandescent units will give satisfactory results.

A trial installation of combined mercury-vapor and incandescent lighting has been in operation in Flat Rock Hydro Plant for three years. The operators report satisfactory results from this combination.

Turbine Rooms

Although not presenting the exacting requirements of control rooms, turbine rooms are nevertheless important from the standpoint of providing adequate illumination, and sometimes present difficult lighting problems.

In general, turbine rooms have high ceilings and are provided with traveling cranes which limit choice of fixtures to high bay units. Where cranes or runways are not available to make the lighting units accessible, the street lighting suspension unit often solves a serious problem in relamping. In most cases, high bay units, properly spaced, will give good results. The high bay unit has a fairly uniform intensity at varying levels and insures good results in general illumination. Control boards in turbine rooms require special consideration, since the nearly vertical rays of the high bay units do not in every case illuminate the vertical surfaces of the control boards sufficiently.

Direct spotlights have been tried with little success. Canopies with indirect lights have been partially successful in illuminating these boards, but are in themselves the cause of shadows on the instrument scales. Louvred floodlights located on nearby columns are sometimes effective for turbine board illumination.

Boiler Rooms

The lighting of boiler rooms follows, in general, the solution of turbine-room lighting problems. Modern boiler rooms have high ceilings, with open areas above the operating aisles. Relighting of older stations is complicated where boiler water gages are located at the water level. Overhead lighting units inject a source of glare in the operator's line of vision, as he watches the water column. Modern plants are being designed with remote water level indicators which permit locating light sources at any point overhead, whereas in the older stations care must be taken that light sources are not located to become a source of glare between operators and water level gages. Also, any light source near the illuminated gages makes them difficult to read. Several remote water level indicating devices are available on the market. The most desirable, from the lighting standpoint, is the periscope principle, which eliminates interference from light sources, and involves no mechanical contrivances which may have questionable reliability.

Painting boiler fronts and major piping with aluminum paint materially assists the solution of the lighting problem. All lighting units in the boiler room should be dust-proof, and fixtures located near pulverized fuel equipment should be of explosion-proof construction.

Switchhouses

Switchhouse lighting is usually not difficult except for compartment lighting, particularly disconnecting switches behind glass doors of high compartments. The Bin type lighting fixture or the asymmetrical glass unit which concentrates the light on the side compartments and shields the source from the aisles is a solution to this problem. Overhead disconnect compartments can often be effectively lighted by using standard fixtures mounted in an inverted position.

Lighting of stairways is an important

and often neglected item although not usually a difficult one. Where possible, emergency stairways and fire towers should be supplied from emergency or separate light sources from main lighting system to insure continuity during outages of station power sources.

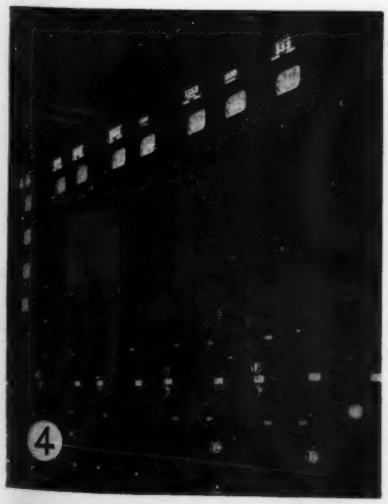
Oil Rooms

Lighting facilities in oil rooms, regardless of material stored, should be of vapor-proof construction. Initially, this precaution will represent little increase in cost and may avert explosion and fire at some future date. Starting contactors should be located outside the room and be remotely controlled from the inside by vapor-proof pushbuttons. From the illumination standpoint the oil room presents no particular problem.

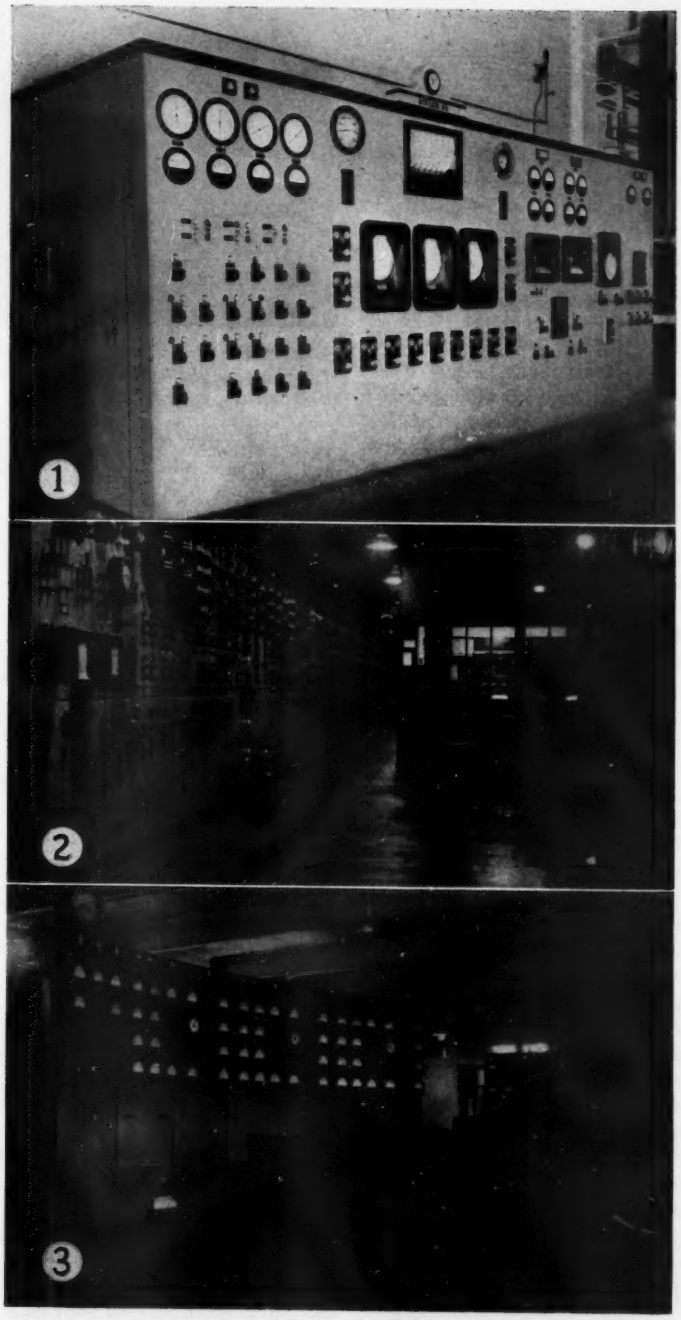
Offices

The larger generating plants are customarily provided with a number of offices, such as plant superintendent, clerical, shift superintendent and boiler room supervisors. The lighting of these offices is just as important as the administrative and engineering offices. However, these items are too often overshadowed by the larger engineering items in the design of a power plant, such as boilers, turbines and generators. The result may mean an inadequate lighting installation which must be corrected after the plant is in operation.

An efficient type of indirect lighting fixture will answer most of the problems of lighting station offices.



4. Switchboard under balcony illuminated by concealed spotlights. The lighter color obtained from the natural slate finish instead of the oiled surface is brought out in this view



1. Boiler control panels at Richmond, first installation of the aluminum finished boards

2. Diffusing units in narrow aisle. This switchboard is all marble

3. Floodlighting of Lamokin Substation instrument board to offset window glare

Outdoor Substations

Outdoor substation lighting involves problems quite different from those encountered in the indoor lighting installations. The surfaces to be illuminated are made up of relatively small, more or less widely separated areas of the structure members and equipment mounted on them. The proximity and exposure of high voltage conductors further complicates the problem. Although outdoor lighting facilities are provided

primarily for operating purposes aesthetics must be taken into consideration because of the tremendous effect good outdoor lighting has on public relations.

In general, outdoor substation lighting will consist of one or a combination of more than one of the following schemes:

1. Overhead or bracket lights.
2. Flood lights.
3. Lighting standards.

The principal advantage of the use of overhead bracket lights mounted on the structure is the low first cost. Maintenance of this type of installation is frequently difficult, and relamping is often hazardous because of proximity to live conductors. In extreme cases it has been necessary to shut down a complete substation to replace safely a burned-out bulb. In some cases street lighting suspension units have solved the hazard problem, but the bracket lights still present a serious glare problem since they are almost invariably located within the operator's field of vision when viewing overhead equipment.

Floodlights overcome the objection to mounting the units on the structures but entail other serious problems such as causing annoying glares to neighbors from the concentrated beams. In addition, the results from use of floodlights on substation structures are not usually an improvement from the aesthetic or advertising viewpoint. For small outdoor substations, particularly those located adjacent to high buildings, the floodlight can often be used to advantage, at low cost. Care must be used in locating floodlights to insure that no beams are directed upward in locations where these beams may interfere with aviation. The ability to adjust the focus of floodlights to preferred sections or equipment when repairs are being made is an advantage of this type of unit.

The street lighting standard has found considerable favor in outdoor substation lighting and provides the most efficient type of lighting equipment since the light source is located away from structures and equipment, the lighting striking them in planes visible from the ground, reducing glare and improving the efficiency of the lighting facilities. Keeping the lights away from high voltage equipment reduces relamping hazards to a minimum. The lighting standard installation is inherently more expensive than the other types but offers the advantages of safety, higher efficiency, and greatest returns from advertising value. Proper illumination of the structures and equipment

District Supervisor's Office in substation. Lighting should be adequate to eliminate need of desk reflectors

overhead from the lighting standards will provide adequate ground lighting by reflection.

Parkway cables help reduce the cost, particularly if used with buried bare neutral wiring scheme.

Protective Lighting

Generating stations, like other industrial establishments, particularly those located in ill-reputed sections of a large city, are subject to intrusion of thieves, vandals and other trespassers. This is sometimes true of unattended substations. Adequate illumination is the best insurance against intruders of any kind, and utility plants can be provided with this protection at relatively low cost. Floodlights located on building roofs sometimes provide sufficient illumination over the entire yard area. Ornamental standards serve both a utilitarian and aesthetic purpose in this connection. The major generating stations of the Philadelphia Electric Company have been equipped with protective lighting installations. In some locations it has been found desirable to illuminate unattended substations with the lighting equipment controlled by time switches.

Emergency Lighting

The need for emergency lighting facilities in generating stations and attended substations has been recognized in the design of practically all existing stations. In fact, in some cases more emergency lighting has been provided than is necessary to safe operation. If uncontrolled, increasing the emergency lighting facilities causes excessive drains on the station control batteries, which is hazardous to restoration of service following shutdown. Allowances should be made in the design of the emergency control and lighting system for later unforeseen additions without overloading the system.

Care should be taken to prevent concentration of emergency lighting feeds in a single source of throwover device which might form a "bottleneck" subject to threat of complete loss of emergency lighting facilities in case of failure of the device or a switchboard fire on the panels where it is located. At least two such throwover devices should be provided in a large station with emergency lighting sources crossed in such a manner that loss of one throwover unit or feed will not result in a loss of all emergency lighting and a serious fire in one section of the plant will not endanger the emergency lighting in that section where it is most needed.

It is desirable, where it can be done economically, to provide an emergency a.c. power feed from an outside source, such as another generating station or substation which can reasonably be expected to be available for supplying lights and ventilating equipment in event of complete station shutdown. In some cases separate small emergency power banks can be connected to generating station tie feeders for this purpose. Consideration is being given to such installations in some Philadelphia Electric Company stations.

Other Properties

Lighting in the main and district offices of the Philadelphia Electric Company has been completely modernized by the Lighting Service Division. The older direct and semi-direct type lighting units have been replaced with totally indirect units, which has increased intensities in some instances as much as 200 per cent. Showrooms with high ceilings have been equipped with direct lighting units assisted by adjustable reflectors mounted behind special diffusing glass to simulate effect of overhead skylights. Intensities as high as 100 foot-candles have been obtained with one of these installations. In one showroom an installation of this type using combined mercury and incandescent units is giving very satisfactory results.

Station workshops have been provided with adequate bench and machine lighting, ranging from 20 to 40 foot-candles, which has eliminated the need for hazardous extension cords increasing personnel efficiency and improving good housekeeping. Installations of combination mercury-vapor and incandescent lighting have been in service for several months in the company machine and forge shops. From the standpoint of effective lighting these installations are excellent, providing an average of 20 foot-candles on lathes and other machine

Floodlighting at Richmond Station

equipment. However, operators report objection to the stroboscopic effect, which, under some conditions, causes rotating machines to appear stationary. It is planned to reconnect the mercury units to distribute them over two phases of the circuits. The stroboscopic effect then is partially neutralized from oppositely connected units. In addition units will be relocated to adjust the combination of mercury and incandescent light.

Another field of illumination covered by the utility engineers is that designed solely for advertising purposes, such as floodlighting and electric signs. One of the Philadelphia Electric Company's large office buildings, the Edison Building, and one of the generating stations, Richmond Station, are floodlighted for advertising purposes. Electric signs are provided at a number of locations. These applications are good sources of revenue and the customers can be more readily sold on their advertising value if the utility has specific examples on its own system.

Conclusions

The best results in lighting control rooms are obtained by the use of totally indirect fixtures in conjunction with light colored surfaces throughout the room, including the switchboard panels and framework. Intensity should be from five to eight f.c. on switchboard surfaces with a minimum of 10 f.c. general illumination. Light colored switchboards not only materially improve the lighting situation and the visibility of devices on the switchboard, but are also conducive to greater efficiency of the operating personnel due to the more favorable psychological reaction to lighter colors. Flush type devices on the switchboards will also assist in obtaining an even intensity of illumination on the switchboard in addition to improving the visibility of the devices.

The most desirable type of finish for switchboards appears to be the aluminum gray which has a high reflection factor without glare and presents no particular cleaning problem. Compounds or metals in natural light color are not at present economically feasible for switchboard material. Visibility of black objects such as lettering, etc., against a white background is materially better than that of white objects against a black background.

High pressure mercury-vapor type lighting units have material advantages when used in conjunction with the proper number of incandescent lamps. Wider application of mercury vapor lamps in future station design may be expected.

Walls and ceilings should be repainted frequently with white, eggshell, or light ivory finish.

Windows should be omitted entirely in control rooms, where it is feasible to do so, to avoid daytime glare conditions.

The street lighting standard appears to have decided advantages for lighting outdoor substations. Lighting fixtures should be kept away from structures and equipment for safety and optimum lighting results. Lighting units must not be arranged with strong beams directed upward which will interfere with aviation.

Suspension type fixtures solve a number of problems in station lighting, but should not be used in locations where the cable supports might create a hazard from adjacent live equipment.

Designers should be liberal in conduit and wire sizes in the initial installation, to accommodate possible future changes and additions. The efficiency of most lighting installations falls as much as 40 per cent after a period of time unless rigidly maintained.

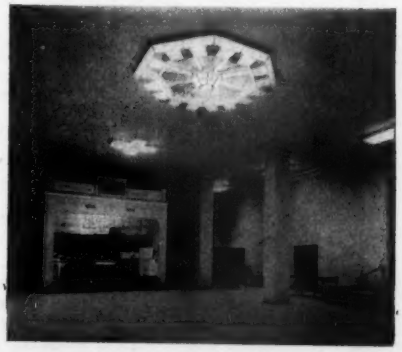
Lamps should be always operated at rated voltage to obtain maximum results from the lighting system.

RECOMMENDED INTENSITIES

	Desirable	Minimum
Control rooms	20	10
Switchboard panels	10	5
Turbine rooms	15	10
Boiler aisles	12	8
Switch aisles	6	3
Pump rooms, oil room	10	5
Supt.'s offices, etc.	20	10
Outdoor substation General	5	3
Outdoor substation Equipment overhead	3	1

The importance of providing adequate lighting of utility properties is becoming more generally recognized, and it naturally follows that this important phase of utility operation will be given an increasing degree of expert engineering attention that is essential to solution of other engineering problems arising in the design or extension of utility properties.

Modernized lighting in offices of Edison Building



Attractive show room lighting is a strong factor in attracting customers

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Rocky Mountain Convention

W. N. CLARK, president of the Southern Colorado Power Company was elected president of the Rocky Mountain Electrical League, at its convention held Aug. 29-31 at Yellowstone Park.

Other officers elected were: J. E. Loiseau, Public Service Company of Colorado, vice-president for Colorado; H. E. Sampson, Southwestern Public Service Company, vice-president for New Mexico; J. W. Alexander, Rawlins Electric Company, vice-president for Wyoming; Lee O'Connell, Westinghouse Electric & Manufacturing Company, vice-president representing manufacturers, contractors, dealers and wholesalers; W. C. Sterne, Arvada Electric Company, treasurer.

C. J. Strike, president of Idaho Power Company, told the members of the League to go direct to the public with a straightforward message of facts as to the conduct of the utility business.

Mr. Strike analyzed the breakdown of the dollar of income received by Idaho Power and showed that municipal or government plants, with 45 per cent outright cash grant and the balance at low interest, put a handicap of 37½ per cent on his company. If the private utility could obtain this, he declared, it would mean a decrease in rates that no government project could equal.

When such facts are interpreted to every business along Main Street, he continued, and such businesses realize that the same principles of tax-exempt, direct-grant competition are advocated for competition of cooperatives with other businesses, the public will realize the unfairness and react against it.

Preceding Mr. Strike, Dan W. Greenberg, manager of Wyoming State Planning Commission, told of the organization of the upper basin states to protect their interests against revision of Boulder Dam power rates that would affect the allotment of funds set forth in the original pact for the upper states' development. J. H. Jacobucci, president of the league, pledged the support of the utilities of these states.

Stricter accounting, rigorous accident prevention, cognizance of the legal aspects of their work, and particularly of personnel and human relation, were seen as new concerns of the engineers by L. M. Robertson, Public Service Company of Colorado and chairman of the league's engineering committee.

In an unscheduled address, George Gadsby, president of Utah Power & Light, called attention to the flattening out of production curves and suggested that increased volume might have to give way to a new ambition to achieve greater public acceptance.

Other speakers at the three-day session were Dr. Adam Bennion, Utah Power & Light Company; Lewis A. Lewis, assistant general manager Washington Water Power Company, speaking for Chairman Sprackling of the National Adequate Wiring Bureau; W. C. Stephenson of the Modern Kitchen Bureau and C. L. Flower, Colorado Public Utilities Commission, who urged uniform accounting methods.

At the final day's meeting the league's long-time lighting program was outlined by Glenn R. Trumbull, manager National Better Light-Better Sight Bureau; E. D. Stryker, incandescent lamp department, General Electric Company; J. T. Coatsworth, chairman of the league's lighting campaign committee. Paul L. Lewis, Nash-Kelvinator Corporation, commended the utilities for the active part they had taken in the National Salesmen's Crusade.

At the banquet held during the convention, William C. Sterne, Arvada Electric Company, was given the league's award of merit. President Jacobucci was also honored in the presentation of a portrait of himself by Charles S. Russell, artist for Public Service Company of Colorado.

Pennsylvania Electric Association Convention

THE Annual Convention of the Pennsylvania Electric Association held at Bedford Springs, September 7-9, was one of the most interesting and valuable gatherings yet held by that organization.

David A. Elias, vice-president of Pennsylvania Power and Light and retiring president of the association, urged greater understanding and cooperation within the industry, from top executive down the line, as one means of solving the engrossing and perplexing problems. He said they were too extensive and wide flung for one mind to solve.

Operating men were cautioned that new economies in design and efficiency in all operations must be found to offset the "crushing burden of taxation, from which there appears to be no relief." This burden must be compensated for, at least in part, Mr. Elias said, by greater results in the field of revenues and economies. He showed that the annual tax burden of electric utilities in Pennsylvania represents $1,000 per employee, or $12 for every customer served.

Mr. Elias urged greater effort in expanding electric service to customers. He saw greater opportunities and markets in farm electrification, but, he said, the farmer must be convinced that electricity can aid his business. As of January 1, 1938, Mr. Elias declared, out of a total potential market of 163,827 Pennsylvania farms which could use electric service, 64 per cent, or more than 105,000 farms, were either enjoying the service or had it available.

The whole operations of the utilities are bogged down with government regulation and supervision, W. H. Swinney, West Penn Power, the new president of the association, told the convention. He said work and progress of the industry have been greatly slowed down. The job ahead, as Mr. Swinney saw it, is to revamp operations to meet changed conditions. He asked for cooperation and effort to meet changing problems so that the industry could continue its march of progress.

The program was studded with well-known speakers. It was unique for a utility convention for it drew heavily on outside interests. Elisha Hanson, general counsel of the American Newspaper Publishers Association, gave his views on what a free press means to America.

Merle Thorpe, editor of the *Nation's Business*, warned the utility operators that the trend of thinking in Washington has gone to the point where there has been written for introduction in Congress a bill which would provide for licensing of voluntary associations—state utility groups and the like.

Dr. Ruth Alexander, writer and economist, Chicago, defended democracy against the trend toward planned economy, classifying such a trend as one toward socialism.

Homely philosophies which have proved their worth would win over the "modern ones," in the opinion of James R. Erwin, President Judge, Court of

Common Pleas, Hudson County, N. J., and Dr. John L. Davis, philosopher, New York City.

Frank W. Lovejoy, sales executive, Socony Vacuum Oil Company, urged the utilities to greater merchandising of their service so that the public will understand the electric bill and what it represents. It is a case of again selling the industry to the public, he said.

E. S. Bayard, editor-in-chief, the *Pennsylvania Farmer,* said that the farmers in Pennsylvania are intensely interested in electricity and its service. "I found every evidence of this, in my discussions with your men, in my interviews with farmers, in the reports of our men, and in public meetings of farmers."

Mr. Bayard declared that both agriculture and electricity are affected by the same fundamental false assumptions —that the wisdom of a few men at Washington is superior to the collective wisdom of all others concerned in these two great industries.

Charles Swartzbaugh, vice-president of N.E.M.A., urged greater co-operation between utility, wholesaler, contractor and manufacturer. He said that the success of the Better Light-Better Sight program was the result of such good relationship. He saw good results from the Modern Kitchen Bureau program on ranges, refrigerators, water heaters and the adequate wiring program.

C. M. Ripley, General Electric, and Roger Bolin, Westinghouse, addressed the convention.

Sir Willmott Lewis, K.C.B.E., dean of foreign correspondents in Washington, closed the convention with a discussion of conditions and political trends in Europe and America.

The round-table discussions held during the afternoon sessions were well attended. The operations section, John M. Orr, Duquesne Light, chairman, demonstrated and discussed five "Vocafilms." Continuing property records and the new accounting order of the Public Service Commission were discussed jointly by the accounting section, E. N. Keller, Philadelphia Electric, chairman, and the engineering section, George S. Van Antwerp, Philadelphia Electric, chairman.

Mr. Elias reported that the systems operation committee has completed its report on economic system loading and "Voltage Nomenclature."

The domestic sales committee has made a study of methods used by member companies in range and water heater promotion, dealer cooperative activities, home lighting advertising, group demonstrations and home lighting surveys.

Mr. Elias said that the hydraulic power committee is now actively studying the subject of flood warnings and operations of hydro-electric plants, but because of the scope and amount of material necessary for collection, it has been impossible to prepare final reports.

Newly elected officers of the association included W. H. Swinney, West Penn Power, president; B. P. Carey, Philadelphia Electric; M. H. Parkinson, Pennsylvania Power & Light, and E. C. Stone, Duquesne Light, vice-presidents; A. B. Millar, managing director, and Harold A. Buch, secretary-treasurer. Mr. Elias, retiring president, remains as a member of the executive committee.

Empire State Gas and Electric Association Convention

ONE hundred and fifty executives and department heads of the various gas and electric utilities in New York State met at the thirty-third annual convention of the Empire State Gas and Electric Association, held at Lake Placid Club on Sept. 15 and 16.

EDWARD P. PREZZANO
New President, Empire State Association

Edward P. Prezzano, President of the Westchester Lighting Company, who a few days before at a meeting of the Executive Committee had been elected President of the Association, presided at the second session of the meeting with Joseph P. Haftenkamp, Vice-President of the Rochester Gas and Electric Corporation, the retiring President of the Association, presiding at the first session. Other officers of the Association elected were: Vice-President, Irving K. Peck, President, Binghamton Gas Works; and Treasurer, Herbert C. Davidson, Vice-President, Consolidated Edison Co. of New York, Inc.

Mr. Haftenkamp opened the convention with a splendid talk on the importance of a continued executive interest in Association affairs.

Alexander Forward, Managing Director of the American Gas Association, spoke for Mr. N. C. McGowen, AGA President who was unable to be present. He outlined the advertising, sales and research programs of the AGA and spoke on the importance of coordination of those efforts by a lively participation by the companies.

Walter C. Beckjord, Vice-President of the Columbia Gas and Electric Corporation, spoke on the Gas Industry in Prospect and Retrospect. He outlined in detail the many successful efforts in sales programs and the market possibilities of the gas industry upon which its future will depend.

Col. John Stilwell, Vice-President of the Consolidated Edison Company of New York, Inc., spoke on the position of the gas and electric industry in regard to their accident records.

Francis J. Brett, Vice-President and Comptroller, Niagara Hudson Power Corporation, gave an inspiring address on the accounting problems facing the industry in New York State as brought about by the adoption of the New Uniform System of Accounts. The importance of uniform interpretation and a plan for a cooperative solution of the accounting problems was outlined by the speaker.

E. H. Thomson, President of the Federal Land Bank of Springfield, spoke on farm conditions as they affected rural electrification. He told of the cooperative effort of the electric companies and the bank in solving the many problems of easements for rights of way over lands mortgaged by the bank. He gave a splendid picture of farm conditions as they affected electrification, pointing out

the necessity of a careful study of the farm community and its markets rather than the individual farm.

C. W. Kellogg, President of the Edison Electric Institute, spoke on "Taking Stock." In his talk he outlined the progress from continued efforts of the institute in its commercial programs. He spoke also on government competition, rate trends and the responsibility of managements in furnishing the best possible electric service as widely and economically as possible.

Hon. Morriss S. Tremaine, Comptroller of the State of New York, spoke on "Water Power Development for the People," supporting his belief in the development of water power at its source in the most economical manner and the lease of the power for distribution by private interests.

Hon. Milo R. Maltbie, Chairman of the Department of Public Service, gave an interesting extemporaneous talk on some of the problems of regulation.

Floyd L. Carlisle, Chairman of the Board, Consolidated Edison Company of New York, Inc., closed the convention with an inspiring address on the business outlook. In it he touched upon international affairs, labor relations, taxes and accounting for depreciation.

Limiting Value of Capacitors When Used as Radio Filters on Portable Appliances*

THE Joint Coordination Committee on Radio Reception of the Edison Electric Institute, the National Electrical Manufacturers Association and the Radio Manufacturers Association has carefully studied the various problems connected with the use of small capacitors on appliances for suppressing radio frequency voltages which may be generated by a make and break contact involved in the operation of the device. These make and break contacts occur at the brushes on commutator motors, at the contacts of thermostats and other similar applications.

The capacitors are connected in such a manner with relation to the make and break contacts as to present a local low impedance path for the radio frequencies. This results in a reduction of the radio frequency voltage impressed upon the supply line. Experience has shown that the capacitor in general should be located as close as possible to the contact and should have connecting leads as short as possible, preferably not over 6 inches long. For specific situations the use of a resistor or reactor associated with the capacitor may be advisable.

In metal frame devices capacitors frequently are connected between the energized conductors of the device and the frame. This practice definitely limits the size of the capacitors in order to avoid the possibility of objectionable shock when a person touches a grounded object and the frame of the device when it is not grounded.

The sensitivity to current of some parts of the hand of most persons, and of all parts of the hand of some persons, is so great that it is impractical to limit the current value so as to be below the threshold value of perceptible current. Furthermore, capacitors of sufficient size to give the best results in suppressing the radio frequency voltages on all devices would give rise to an unpleasant sensation of shock in many cases. The value therefore is a compromise which should allow an acceptable degree of radio frequency voltage suppression in most cases and which should not introduce an appreciable possibility of sense of shock for the large majority of individuals under usual conditions.

RECOMMENDATIONS

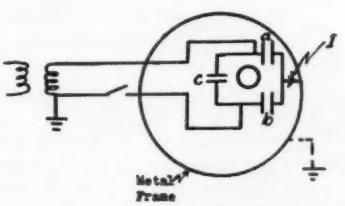
As a result of this study the Joint Committee has recommended, as tentative limits, that the maximum value of capacitor to be connected between the windings and the case shall be such that the current to ground through this capacitor as connected and used cannot exceed 0.3 milliampere with the switch or switches of the device in any position. Devices rated at 110 to 120 volts shall be assumed to operate at 120 volts and at rated frequency. The accompanying diagrams illustrate the application of this limitation.

EXCEPTIONS

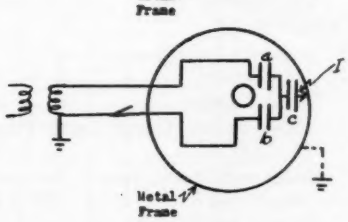
This study has not included consideration of devices where the frame is permanently grounded or where there is little likelihood of contact by an individual with the metal frame. Oil burners, pump motors, etc. generally fall in the former class and most radio sets fall in this latter class. For such devices the limitation on size of capacitors due to the possibility of shock does not in general apply.

No consideration has been given to the make and break of switches which as a rule are operated infrequently.

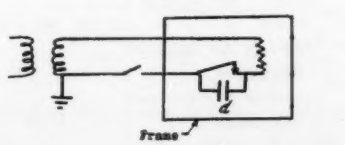
It is recognized that this limiting current value may be subject to revision after further field experience with it.



Capacitors "a" and "b" in parallel shall be of such size as to limit the current I to 0.3 milliamperes. The value of "c" is not limited.



Capacitors "a" and "b" not limited in size. Capacitor "c" limited in size so that the current I through c in series with "a" and "b" in parallel shall not exceed 0.3 milliamperes.



Capacitor "d" not limited in size by these requirements.

Explanatory diagrams—(not connection diagrams).

*A Report of the Joint Coordination Committee on Radio Reception of EEI, NEMA, and RMA.

Program

E.E.I. Accident Prevention Committee Meeting

L. M. SHADGETT, *Chairman*

The Chamberlin Hotel, Old Point Comfort, Va.
October 6 and 7, 1938

October 6—9:30 a.m.-5:30 p.m.

Announcements, etc.
Minutes of Last (Ninth) Meeting
Statistics.....C. R. BEARDSLEY
Cause and Locus Data....W. A. BUCHANAN
Low Voltage Hazards.....A. B. CAMPBELL
Rubber Protective Equipment.M. F. SKINKER
Public Safety .....H. J. BURTON
Luncheon
Employee Health .....WILLS MACLACHLAN
Artificial Resuscitation..WILLS MACLACHLAN
Office Hazards .....E. R. KROPP
Principles of Hold-Off.....D. C. STEWART
Line Hazards .....E. C. RUE
Traffic Hazards .....C. N. RAKESTRAW
Hazards Due to the Use of CO_2 Fire Extinguishing Equipment ....G. S. DIEHL
National Safety Council Affairs .....R. M. GODWIN

October 7—9.30 a.m.-5:30 p.m.

Announcements, etc.
Employee Training .....A. S. BENNION
Reports from Men Contacting Other EEI Committees
Transmission and Distribution..E. C. RUE
Insurance and Accounting....E. R. KROPP
Electrical Equipment .....D. C. STEWART
Prime Movers and Hydraulic Power .....G. S. DIEHL
Affairs of A. I. E. E. Committee on Safety .....WILLS MACLACHLAN
New Ideas and Devices
New Business
Adjourn

Program

E.E.I. Electrical Equipment Committee Meeting

H. L. WALLAU, *Chairman*

The Chamberlin Hotel, Old Point Comfort, Va.
October 10 and 11, 1938

October 10—9:30 a.m. Closed Session
(Only Committee Members and representatives of E.E.I. Member Companies are invited to this session.)
H. L. WALLAU, *Chairman*

Opening Remarks .....H. L. WALLAU
Oil Fire Reports .....R. N. CONWELL
Apparatus Troubles .....C. A. CORNEY
O. C. B. Bushing Reports..R. W. WILBRAHAM
Announcements .....J. O'R. COLEMAN
Tests on a Modernized Oil Circuit Breaker .....H. E. DEARDORFF
Announcement re Manufacturers Revised O. C. B. Ratings and Oil Circuit Breaker Timing .....S. M. DEAN
Report on Bus Protection Questionnaire .....H. L. WALLAU
General Open Discussion

October 10—11:00 a.m. Open Session
Foreign Practice Group
A. H. LAWTON, *Chairman*

Progress Reports .....A. V. DE BEECH
Meters & Services Division
A. E. SILVER, *Chairman*
Progress Reports .....A. E. SILVER
Operating and Maintenance Division
H. S. FITCH, *Chairman*
Progress Reports re:
Storage Batteries .....H. S. FITCH
Rehabilitation of Insulation Oils .....H. S. FITCH
Final Report on Rehabilitation of Flood Damaged Apparatus .....H. S. FITCH
Announcements

October 10—2:00 p.m. Open Session
Apparatus and Design Division
B. VAN NESS, JR., *Chairman*

Generator Insulation and Testing .....B. VAN NESS, JR.
Progress Report Subject Committee .....B. VAN NESS, JR.
Progress Report No. 2, N. E. Power Service Co. .....H. R. STEWART
Station Design .....H. B. WOOD
Steel Mill Substation Birmingham .....L. M. SMITH
Station Lighting .....R. A. HENTZ
Station Service Layout Logan Plant A.G.&E. Co. .....P. SPORN
Design and Manufacture of 2300-volt Air Circuit .....WM. DEAN
Breakers Installed at Logan Plant.....ITE CIRCUIT BREAKER CO.
2300-volt Air Breakers Discussion .....D. M. JONES
2300-volt Air Breakers Discussion .....C. A. POWEL
General open discussion

October 11—9:00 a.m. Open Session
Utilization Division
J. H. FOOTE, *Chairman*

Progress Reports re:
Water Heaters .....J. H. FOOTE
Ranges .....J. H. FOOTE
Resistance Welders .....J. H. FOOTE
System Engineering Division
R. A. HENTZ, *Chairman*
Normal and Emergency Ratings .....F. D. WYATT
System Planning of the Public Service Electric & Gas Co.....R. N. CONWELL

October 11—1:30 p.m. Joint Session
Electrical Equipment Committee
Transmission and Distribution Committee
H. P. SEELYE and H. L. WALLAU, *Chairmen*

Street Lighting .....F. D. CROWTHER
Radio Dispatching of Trouble Crews .....J. W. DRUMMOND
Basis of Investment for Increased Reliability—Service Outages..S. M. DEAN
Prepared Discussion by.....T. H. HAINES
Prepared Discussion by.....P. H. CHASE
Reports:
(a) Utilization Voltages.....J. H. FOOTE
(b) Continuing Property Records .....M. ELDREDGE
Continuing Property Records .....R. A. HENTZ
(c) Principles of Hold-Off....H. S. FITCH
(d) Ratings for Registration Statements .....H. E. DEARDORFF

E.E.I. Prime Movers Committee Meeting

THE fall meeting of the Prime Movers Committee, W. E. Caldwell, chairman, will be held at the Union Building of the University of Michigan, Ann Arbor, Monday and Tuesday, October 3 and 4. The committee meeting will be called to order at 9:30 a. m. on both days.

The Subcommittees on Boilers, Combustion, Oil and Gas Engines, Chemistry, and Turbines, will report on left-over items from last year's work, and review in detail their plans for the coming year.

A special feature of the meeting will be a thorough and careful review of the problems associated with specifications for materials and piping for use at high temperatures. Included in this discussion will be a review of the specifications and experience of the members in obtaining carbon molybdenum piping.

Arrangements have been made for an inspection trip of University Laboratories, and of some of the Detroit Edison Company plants on Tuesday afternoon.

Program

E.E.I. Transmission and Distribution Committee Meeting

H. P. SEELYE, *Chairman*

The Chamberlin Hotel, Old Point Comfort, Va.
October 11 and 12, 1938

PRELIMINARY MEETINGS

October 10—9:30 a. m.-5:00 p. m.
Subject Committee on Underground Methods and Accessories
J. A. BROOKS, *Sponsor*

Recent Network Cable Tests..J. W. BENNETT
Recent Developments in Cable Fault Location .....J. A. VAHEY
Gas-Tight Non-Porous Wipes on Lead Cable Sheathing .....K. S. WYATT
Impulse Dielectric Strength Tests .....E. W. DAVIS
Discussion on Vertical Terminations of Paper Cable I.P.C.E.A.
Discussion of Cable Operations Report .....E. R. THOMAS
Discussion of Network Operation Report .....E. W. OESTERREICH

October 10—2:00 p. m.
Subject Committee on Distribution Economics
MERRILL DEMERIT, *Sponsor*

Discussion of Field Testing of Loads on Distribution Transformers

REGULAR SESSIONS

October 11—9:30 a. m. Open Session
Underground Group
C. W. FRANKLIN, *Chairman*

Network Supply When Intermeshed from both Generating Stations and Substations .....T. MAXWELL
Semi-Underground Distribution System for Benton Harbor, Mich. ....R. E. MORSE
Discussion of Evansville Semi-underground System (Paper presented at meeting in May, 1938, by E. V. SAYLES
Cable Operation Report .....E. R. THOMAS
Network Operation Report .....E. D. OESTERREICH

Standards and Specifications Group
E. V. SAYLES, *Chairman*

Standardization of Distribution Transformers .....H. F. MCRELL
Progress Reports
(a) Subcommittee on Line Hardware
(b) Subcommittee on Crossarms
(c) Subcommittee on Insulators

Plant Coordination Group
W. F. DAVIDSON, *Chairman*

Current Cases

October 11—1:30 p. m. Joint Session
Joint Meeting of Transmission and Distribution and Electrical Equipment Committees
(See Electrical Equipment Committee Meetings for this program.)

October 12—9:30 a. m. Open Session
Overhead Distribution Group
W. F. NIMMO, *Chairman*

Ground Line Treatment of Standing Poles .....F. W. PACKER
Trees and Their Relationships to Overhead Power Lines.....G. D. BLAIR
A Method of Apportioning Design Voltage Drops for Overhead Residential Distribution Circuits.....C. E. ARVIDSON
Report on Lightning Protection of Distribution Transformers...L. G. SMITH
Field Testing of Distribution Transformers .....F. E. SANFORD

October 12—2:00 p. m. Closed Session

Report on Service Restoring Fuses and Switches .....C. V. WADDINGTON
Auto-Transformer for Common Neutral Radial Distribution Systems..W. B. ELMER
National Electrical Safety Code Revision
Round Table Discussion

Only Two Places of More Than 1,000 People in the U. S. Are Without Electric Service

ACCORDING to the tabulations of the Federal Power Commission's "Rate Series B," there were only 134 communities of 250 or more people in the United States that were without electric service on January 1, 1937. The total population of these 132 places was 50,979. Of the total number only two had a population of 1000 or more. Of the remainder, only 14, with a total population of 9426, had between 500 and 1000 population, leaving 118 communities with populations between 250 and 500 still unserved. Two-thirds of the unserved communities were in the South, while in 19 states every single place had electric service.

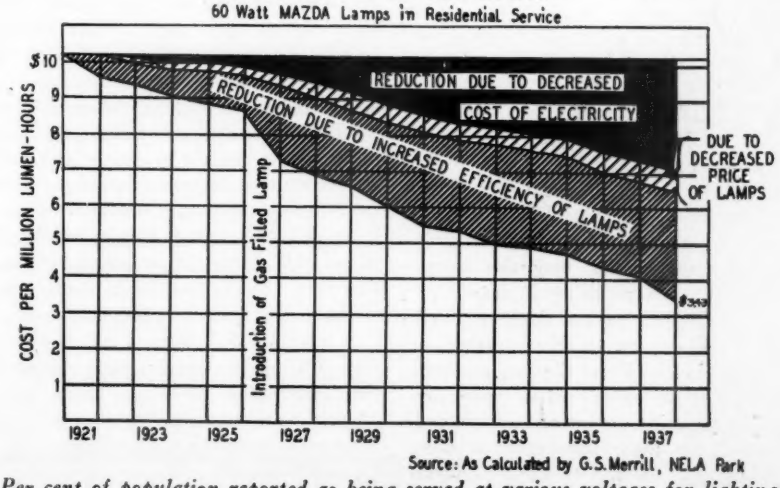
Central Station Voltages for Lighting

By G. S. Merrill
General Electric Company

OUR annual analysis of population reported as being served at various lighting voltages, shows a continued shift toward 120, with decreases in both the 115 and the 110-volt percentages. The percentage of population receiving lighting service at 125 and 130 volts is almost negligible (actually less than one-tenth of one per cent) and shows no sign of increasing. The trend is as shown in the following table, and is illustrated in the accompanying figure.

PER CENT OF U. S. POPULATION IN AREAS SUPPLIED AT DIFFERENT VOLTAGES—100-130 VOLT RANGE

Voltage	1923	1928	1933	1937	1938
110	36.3	15.9	5.2	1.8	1.4
115	40.9	61.6	61.7	52.1	49.5
120	19.4	22.4	33.0	46.0	49.0
All Others	3.4	0.1	0.1	0.1	0.1
Total	100.0	100.0	100.0	100.0	100.0
Average Voltage (1st three items only)	114.1	115.3	116.4	117.2	117.4



Per cent of population reported as being served at various voltages for lighting—100-130 volt range

RECENT PUBLICATIONS

INDUCTIVE COORDINATION OF RURAL POWER AND TELEPHONE SYSTEMS

E.E.I. Pub. F-2. A report of the Joint Subcommittee on Development and Research, Edison Electric Institute and Bell Telephone System, 59 pages. Price 80¢ to members and their employees; $2.00 to non-members in the U.S.A.; $2.15 to foreign countries.

RESULTS are given in this report of a study of the factors affecting the inductive coordination of rural power and telephone systems at noise frequencies. Methods are described for estimating the inductive influence of various types of rural power circuits and the noise in exposed telephone lines. Coordinative measures applicable in the power and telephone systems are discussed.

DESIGN OF SWITCHHOUSES FOR GENERATING STATIONS AND TRANSMISSION SUBSTATIONS

E.E.I. Pub. F-5. A report of the Electrical Equipment Committee, Edison Electric Institute, 21 pages. Price 40¢ to members and their employees; $1.00 to non-members in the U.S.A.; $1.10 to foreign countries.

THIS report presents information on the basic design of switchhouses operating at voltages between 11 kv and 24 kv. It includes reports on specific projects of eleven operating companies, covering twelve generating stations and one transmission substation. In addition, comments of a general character from five other companies are included.

ECONOMICAL DISTRIBUTION TRANSFORMER LOADING AND THERMAL PERFORMANCE OF DISTRIBUTION TRANSFORMERS

E.E.I. Pub. F-7. A report of the Transmission and Distribution Committee, Edison Electric Institute, 17 pages. Price 40¢ to members and their employees; $1.00 to non-members in the U.S.A.; $1.10 to foreign countries.

ADEQUATE transformer loading is a major factor in economical distribution of electrical energy. Underloading is costly in producing excess investment although it is sometimes necessary to meet voltage requirements. Excessive overloading may also be expensive due to resulting high maintenance. The first part of this report contains a discussion of the number of problems involved and the fundamentals which must be considered in connection with any specific system or kind of load. One of the most important of these fundamentals is the thermal performance of distribution transformers.

The second part of this report contains a complete description of a method of determining the safe load of any load cycle which any specific distribution transformer can carry. Test data are included as well as empirical means of determining the necessary constants of a 2,400 volt transformer of any design and size from the weight of copper and core and of the transformer. By this method the oil temperature and hot-spot temperature of a transformer can be pre-determined with a degree of accuracy adequate for practical use if the load curve of the transformer is known.

A related E.E.I. Report No. F-3 contains 140 weekly characteristic distribution load curves by hours, taken from graphic chart tests covering a wide range of seasons, geography, transformer size, appliance density, customer use, companies and rates. The effects of the different charactistics of those loads on transformer life and internal temperature is therein analyzed by the method described in this report.

LIGHTNING PROOF TRANSMISSION LINES

E.E.I. Pub. F-6. A report of the Transmission and Distribution Committee, Edison Electric Institute, 34 pages. Price 60¢ to members and their employees; $1.50 to non-members in the U.S.A.; $1.60 to foreign countries.

WITH the added knowledge obtained in the last ten years, old transmission lines have been reconstructed at relatively low cost and new transmission lines designed so that interruptions have been decreased to a fraction of former values. Operating records show this improvement and the theory derived from tests and experience has been incorporated in principles of design for ready application to new lines or the reconstruction of old ones.

CONVENTIONS AND MEETINGS

SEPTEMBER

1	Illuminating Engineering Society, Nicollet Hotel, Minneapolis, Minn.
7-9	Pennsylvania Electrical Association, Bedford Springs Hotel, Bedford Springs, Pa.
9-10	Maryland Utilities Association, George Washington Hotel, Ocean City, Md.
12-15	National Electrical Contractors Association, Book-Cadillac Hotel, Detroit, Mich.
12-15	International Municipal Signal Association, Lord Baltimore Hotel, Baltimore, Md.
15-16	Empire State Gas and Electric Association, Lake Placid Club, Lake Placid, N. Y.
19-20	Wisconsin Utilities Association, Transportation Section, Lawsonia, Green Lake, Wis.
22-24	American Trade Association Executives, William Penn Hotel, Pittsburgh, Pa.
23-24	Wisconsin Utilities Association, Accounting Section, Lawsonia, Green Lake, Wis.
29-30	Indiana Electric Association, French Lick Springs Hotel, French Lick Springs, Ind.
30	Public Utilities Association of West Virginia, The Greenbrier Hotel, White Sulphur Springs, W. Va.

OCTOBER

1	Indiana Electric Association, French Lick Springs Hotel, French Lick Springs, Ind.
1	Public Utilities Association of West Virginia, The Greenbrier Hotel, White Sulphur Springs, W. Va.
3-4	Prime Movers Committee, EEI, University of Michigan, Ann Arbor, Mich.
3-6	American Transit Association, The Royal York Hotel, Toronto, Canada.
3-7	National Restaurant Association, Chicago, Ill.
5-9	Electrical Manufacturers Club, The Homestead, Hot Springs, Va.
6-7	Accident Prevention Committee, EEI, Chamberlain Hotel, Old Point Comfort, Va.
10-11	Electrical Equipment Committee, EEI, Chamberlain Hotel, Old Point Comfort, Va.
10-14	American Gas Association, Atlantic City, N. J.
10-14	National Safety Council, Stevens Hotel, Chicago, Ill.
11-12	Transmission and Distribution Committee, EEI, Chamberlain Hotel, Old Point Comfort, Va.
17-20	National Electrical Wholesalers Association, Drake Hotel, Chicago, Ill.
24-25	Wisconsin Utilities Association, Commercial and Technical Divisions of Electric Section, Schroeder Hotel, Milwaukee, Wis.
24-28	National Electrical Manufacturers Association, Palmer House, Chicago, Ill.

NOVEMBER

15-18	National Association of Railroad and Utilities Commissioners. New Orleans, La.